Compressed Air Magazine

AUGUST 1943

ACTION AT SEA

The fleet moves quickly to repel aerial attackers.

VOLUME 48 • NUMBER 8

NEW YORK • LONDON

IMMEDIATE DELIVERY FROM A ROCKWOOD DEALER NEAR YOU

Rockwood V-Belt Sheaves
Rockwood V-Belts
Complete V-Belt Drives

Rockwood Pivoted Motor Bases
Complete flat belt drives

7988 Stock Sizes V-belt Sheaves
1447 Stock Sizes Paper Pulleys
All Sections and Lengths V-belts

For over 12 years we have been installing Rockwood Pivoted Motor Base Drives to belt driven compressors and getting increases in compressor capacities—often as high as 10% to 15%. HOW ABOUT YOUR BELTED COMPRESSOR? If it has an adjustable idler or has the motor mounted on old fashioned motor slide rails IT IS NOT OPERATING TO CAPACITY. The belts are stretching under load, then slipping and the compressor is bound to slow down at load peaks and its capacity reduced.

MAKE THIS SIMPLE, INEXPENSIVE CHANGE. Install a Rockwood automatic belt tightening motor base and the belt is always tight, regardless of changes in belt length or loads. The compressor is kept uniformly to speed—its capacity increased—it does better work—requires less maintenance. AND THE BELTS LAST TWICE AS LONG.

LET US HEAR FROM YOU. See your Rockwood dealer or we will take care of you. Bases are in stock for all N.E.M.S. stock size motors. In semi-stock for motors up to 250 h.p. Larger sizes built with small delay.

ROCKWOOD

INDIANAPOLIS • U.S.A.

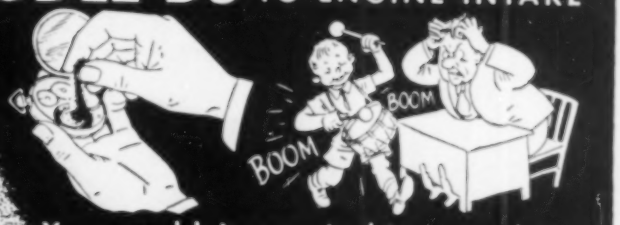
Specialists in Power Transmission Equipment Since 1884

"KEEP 'EM RUNNING"

at Maximum Output — with Minimum Trouble

The chips are down. American industry faces its most crucial test. Production facilities are strained to the utmost as governmental and civilian orders pile up. Equipment must be at peak efficiency. Be sure all compressors, pumps and internal combustion engines are equipped for maximum output, minimum maintenance. Equip each one NOW with Protectomotor Intake Filters. Stop trouble where it frequently starts—in abrasive dust that wears reciprocating parts and clogs valves, reducing production as it increases chances for trouble. Keep 'em running, America—equip with Protectomotors NOW!

MODEL DS SILENCES, FILTERS AIR TO ENGINE INTAKE



You wouldn't permit this . . . or this

WHY LET UNPROTECTED INTAKES DRAW IN DUST - - - CAUSE EXCESSIVE NOISE?

The Model DS Protectomotor is the only device that not only prevents the intake of dust to air-breathing machines, but also silences the intake sound.

Construction is simple, rugged and effective, possessing many exclusive, patented features and special advantages:

A. Series of cylindrical rectifying chambers of scientific diameter to length ratio which smooths out sound waves.
B. Dry Feltex Filtering Medium more than 99% efficient by University of California Laboratory tests.
C. Radial Fin Construction. Permits large area of filtering medium to occupy smallest possible space.
D. Rigid, galvanized mesh frame.
E. Reinforcing tube. The Model DS Protectomotor is "built like a battleship."

MODEL D INTAKE FILTER extensively used on intake of engines and compressors where noise elimination is not important. Same construction as Model DS except for silencing features.

WRITE FOR CATALOG describing filters for engines, pipe lines, ventilation, etc.

STAYNEW FILTER CORP.

"Air Filter Headquarters"

7 Centre Park, Rochester, N. Y.

PROTECTOMOTOR AIR FILTERS

NEW

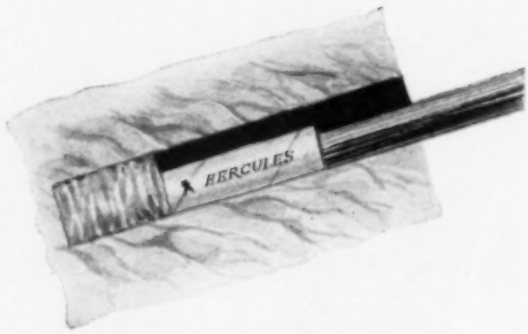
SLIGHTEST TRACES OF OIL REMOVED FROM AIR TRANSMISSION LINES WITH LATEST PROTECTOMOTOR, MODEL AAPHS PIPE LINE FILTER. Staynew engineers have designed an entirely new type of pipe line filter, now used extensively for the protection of delicate air-powered control devices. This new filter, the Model AAPHS, prevents the passage of the most minute traces of vaporized oil. The AAPHS is actually a "super" filter, used in most applications as the final of two or more stages of filtration.

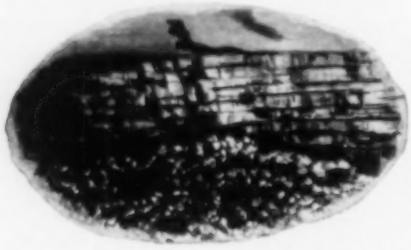
Construction Features: (1) inlet; (2) baffle; (3) solid Feltex Discs through which all air must pass; (4) carrier tube; (5) outlet; (6) shell; (7) drain cock.

TAMPTITE* an answer to manpower shortages

Saves Time, Labor

Without changing your method of operation, Hercules Tamptite saves you time, labor, and expense. You drill your holes the usual way. You use your regular grade and size of Hercules explosive. And you tamp the charge in the usual manner. Everything is the same except that Tamptite permits faster loading of holes, and eliminates the wasted time and trouble of slitting cartridges.





Better Breakage

When you tamp a Tamptite cartridge, the dynamite expands but remains within the wrapper. This fills the bore hole snugly, leaves little air space, concentrates the charge where it is most effective. Naturally, the result is better breakage of the ore or rock and faster mucking, easier handling.

Five Types

Your customary grades and sizes of Hercules explosives—Gelamites*, Hercomites*, Extra Gelatins, Gelatins, and Extra Dynamites—are all available in Tamptite cartridges. To get the greater efficiency of the Tamptite cartridge, specify Hercules on your next dynamite order.

*Reg. U. S. Patent Office

HERCULES EXPLOSIVES

HERCULES POWDER COMPANY
INCORPORATED

932 KING STREET, WILMINGTON, DELAWARE

PROTECTED from flying particles of grit and metal by his "diver's" helmet, this aircraft worker is sand-blasting the fuselage frame of a PT-17 Primary Trainer. Furnishing air at over 100 lbs. pressure to do this work, as well as supplying a light wash of fresh air within the helmet, are important uses of air compressors.

To keep air compressors at maximum efficiency, not only for this vital war work, but for all types of industrial service throughout America, operators everywhere are lubricating them with Texaco.

Texaco Alcaid, Algol or Ursa Oils keep compressors free from hard carbon deposits. Valves open wide and shut pressure-tight; rings stay free, ports and air lines clear.

So effective have Texaco lubricants proved in increasing output that they are definitely preferred in many important fields, a few of which are listed in the panel.

A Texaco Lubrication Engineer will gladly cooperate in the selection of the most suitable lubricants for your equipment. Just phone the nearest of more than 2300 Texaco distributing points in the 48 States, or write:

The Texas Company, 135 East 42nd Street, New York 17, N. Y.

THEY PREFER TEXACO

★ More revenue airline miles in the U. S. are flown with Texaco than with any other brand.

★ More buses, more bus lines and more bus-miles are lubricated and fueled with Texaco than with any other brand.

★ More stationary Diesel horsepower in the U. S. is lubricated with Texaco than with any other brand.

★ More Diesel horsepower on streamlined trains in the U. S. is lubricated with Texaco than with all other brands combined.

★ More locomotives and railroad cars in the U. S. are lubricated with Texaco than with any other brand.

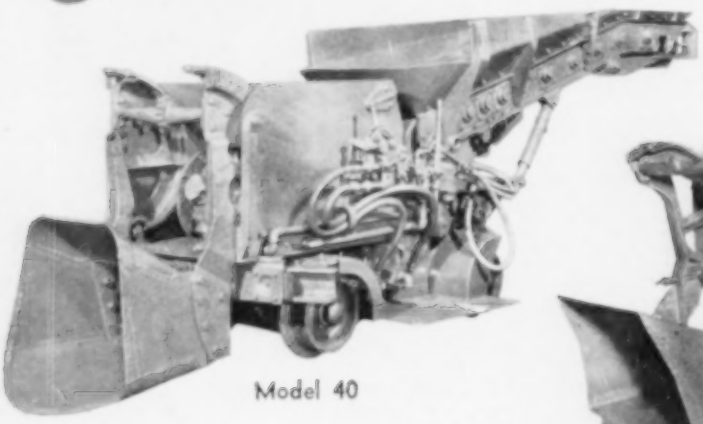
TEXACO

TEXACO Lubricants and Fuels

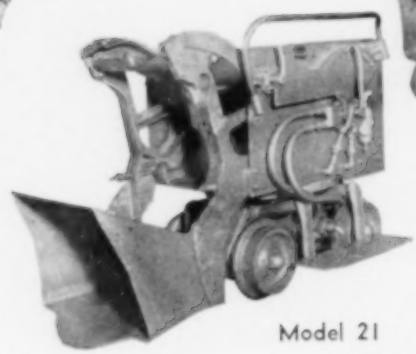
FOR ALL AIR COMPRESSORS AND TOOLS

TUNE IN THE TEXACO STAR THEATRE EVERY SUNDAY NIGHT — CBS ★ HELP WIN THE WAR BY RETURNING EMPTY DRUMS PROMPTLY

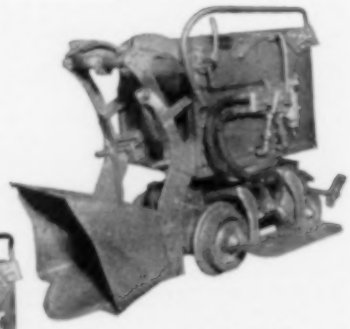
These-



Model 40



Model 21



Model 12-B

are the Loaders

Eimco, alone, offers a complete line of loader sizes for every job, each distinct in design and best suited for its field of service.

MODEL 12B equipped with heavy duty five cylinder pneumatic motors, capacity 1 to 2 tons per minute and weighs 4200 pounds; track gauges 15" to 36". Popular with large and small mines alike.

MODEL 21 powered by heavy duty five cylinder pneumatic motors, capacity 2 to 3 tons per minute and weighs 7200 pounds; track gauges 18" to 48". USED EXCLUSIVELY AT THE CARLTON AND ON THE CONTINENTAL DIVIDE TUNNELS WHERE WORLD'S RECORDS WERE MADE.

MODEL 40 equipped with a ½ cubic yard bucket, powered by air or electric motors, capacity 3 to 4 tons per minute and weighs 14,000 pounds; track gauges 30" to standard railroad gauge. OUTSTANDING IN LARGE HEADINGS AND NOW WIDELY USED IN THE NORTHERN AND SOUTHERN IRON FIELDS.

that muck the ore

that feed the mills

that supply the plants

that make munitions

that keep the boys

fighting for VICTORY

Consult an Eimco Engineer and be assured of getting the right loader for the job. Bulletin 105 will be sent on request.

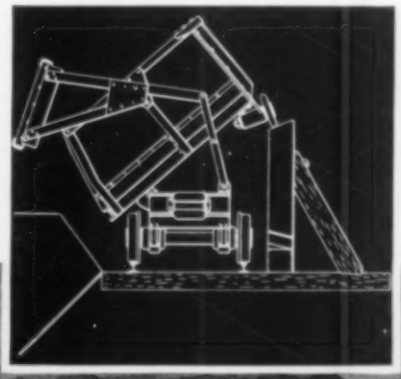
THE EIMCO CORPORATION

SALT LAKE CITY, UTAH, U.S.A.

NEW YORK	CHICAGO	EL PASO	SACRAMENTO
120 Broadway	111 W. Washington St.	Mills Bldg.	1217 7th St.

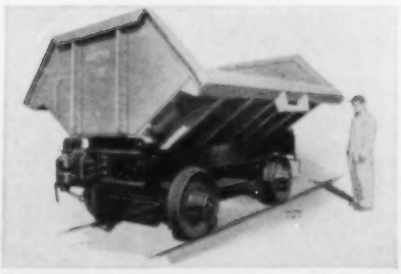
EASTON GRANBY CARS

A fundamentally sound design which combines low overall height with large capacity for mine haulage. One of many Easton mine car designs, the Granby is moving mountains of ore daily in iron, lead, zinc, limestone and other underground mining operations. Diagram at left shows how Granby car is dumped automatically when roller at back rides over the inclined rail. Easton designs and installs the complete system.



Keep moving with EASTON

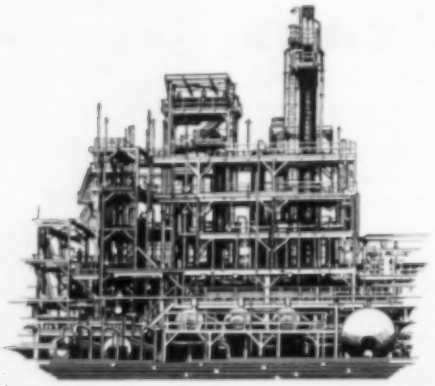
It is *your* job to keep mountains of earth, ore and rock moving from where they are to where they are needed in the War Production Program. It is *our* job to help you to design track or trackless haulage equipment to fit your requirements, to adapt the design to the availability of materials, and to follow each order through to earliest possible delivery. May we get to work on your haulage problem *now*—to help you achieve your desired capacity at lowest cost per ton? Write to Easton Car & Construction Company, Easton, Pa.



The famous EASTON Phoenix Quarry Car. Doorless. 2-way dump. Timken Bearings.

EASTON Cornwall Mine Car. With automatic downfolding door. Timken Bearings.

The EASTON TR-15H Trackless Mine Car. A matchless record in quarry service.



BUTADIENE PLANTS

use steam-jet ejectors

The Standard Oil Development Company and E. B. Badger & Sons Company, designers and constructors of butadiene plants, were confronted with an unusual gas handling problem. Hydrocarbon gases at 1200°F. had to be compressed to 15 psi. gauge using steam at 1400°F.—and the gases and steam must be intimately mixed.

Ingersoll-Rand was consulted, and after building and operating an experimental unit, recommended a steam-jet ejector for the job.

These ejectors are operating successfully in butadiene plants and others are being installed in plants now under construction. Special materials to resist high temperatures are employed—and a novel suction chamber design simplifies the installation piping.

This is just one example of Ingersoll-Rand engineering service. May we help you?

Ingersoll-Rand

11 BROADWAY, NEW YORK, N. Y.

4-326

CENTRIFUGAL PUMPS • CONDENSERS • COMPRESSORS • TURBO BLOWERS • ROCK DRILLS • AIR TOOLS • OIL AND GAS ENGINES

READY! Simplified Catalog of G-E Renewal Parts

HELPS GET PARTS FASTER

- ✓ Quickly identifies needed parts—pictorially!
- ✓ Simplifies ordering by catalog number
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- ✓ Gives dimensions, descriptions, prices on all parts required most frequently
- ✓ Includes parts for G-E motors, control, switchgear and other widely used electric equipment; also supplies, such as magnet wire, insulating materials
- ✓ Makes it easier to order *genuine* G-E parts, for better fit and long-lasting performance

NOW, a single book—indexed for easy reference—can take the place of separate handbooks and bulletins for identifying and ordering most G-E renewal parts needed to keep your equipment in operation. With this book, you'll find it easier to order genuine G-E parts *by catalog number*—saving time all along the line.

For your copy, just mail the coupon. Even though you don't need it now, it may save precious hours in an emergency. *General Electric Company, Schenectady, N. Y.*

GENERAL ELECTRIC

General Electric Co., Section Q 750-220
Schenectady, N. Y.

Yes, I want a copy of your new 96-page catalog "Renewal Parts and Supplies (GEA-638)" to help simplify ordering of genuine G-E parts.

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Company.....

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City..... State.....

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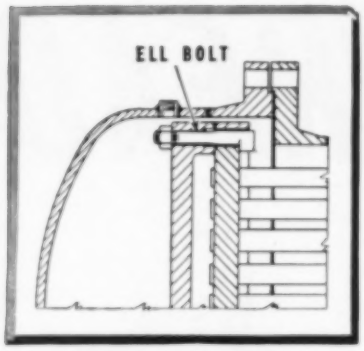
ELL BOLT
CONSTRUCTION
a feature of the Patented
VOGT HEAT EXCHANGER
Floating Tube Sheet Assembly



Patent Nos.
1,895,735
2,232,478

Assures
NO LEAKS HERE

YOU LOSE when an exchanger leaks . . . . with the possibility of fluid contamination, or shut down for repairs.

None of these evils need plague you when you employ the Vogt patented floating tube sheet assembly because there is no distortion of a split ring to worry about in making up the joint time after time. Its easy to make tight and it stays tight!

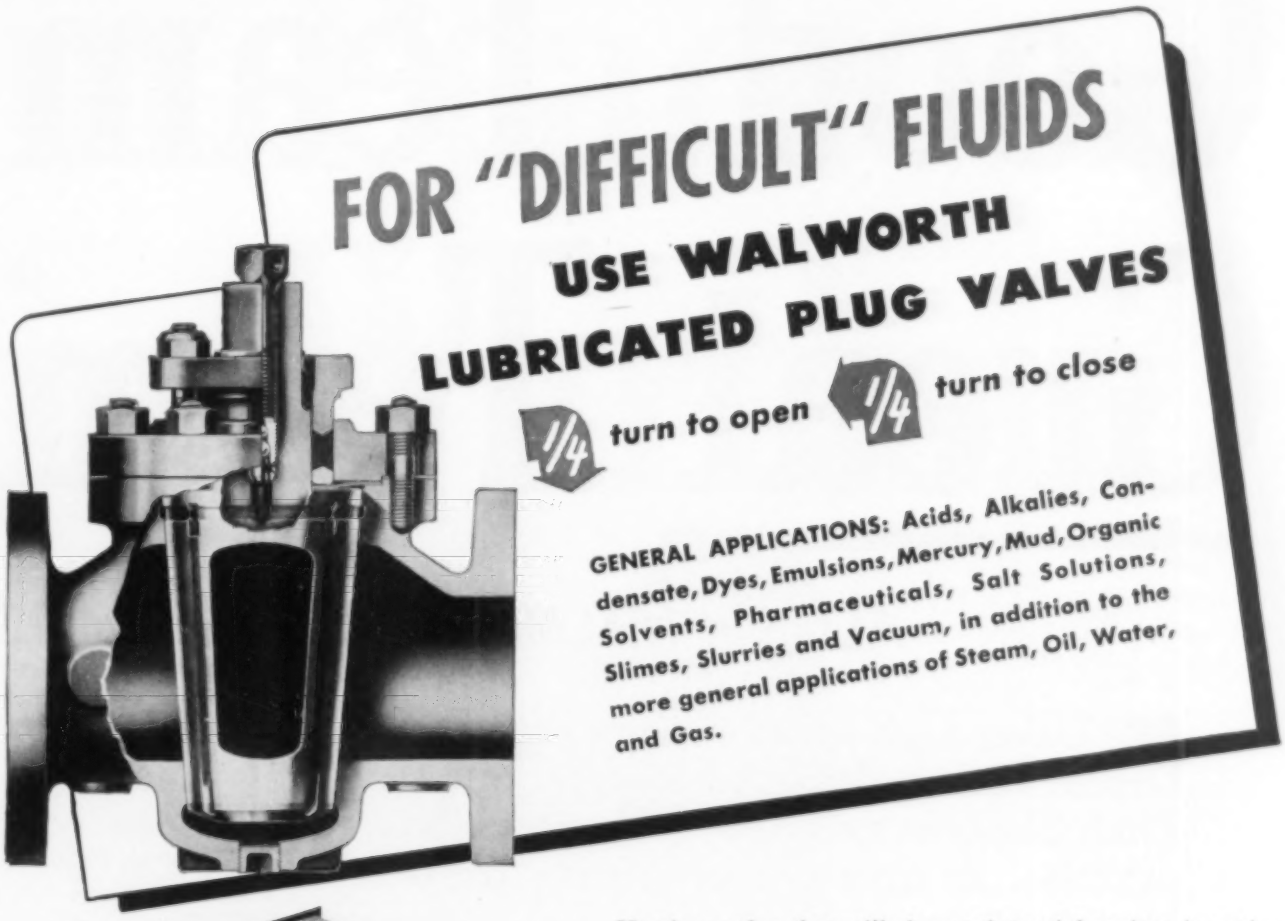
Critical materials are saved too because the design makes possible a smaller diameter of shell through reduction of the dead space between the shell and the tube bundle.

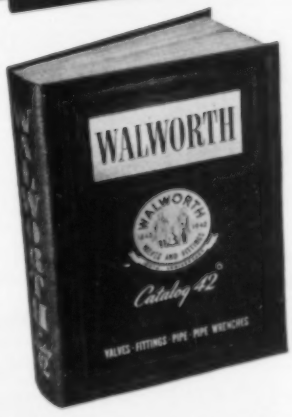
Our new bulletin HE-5 is a pictorial presentation of standard and special types of Vogt Heat Exchangers. Write for a copy on your letter head.

HENRY VOGT MACHINE COMPANY
Incorporated
LOUISVILLE 10, KENTUCKY
Branch Offices: New York, Philadelphia, Cleveland, Chicago, Dallas.

Vogt *Heat Transfer* EQUIPMENT

FIT THE VALVE TO THE SERVICE


FOR "DIFFICULT" FLUIDS
USE WALWORTH
LUBRICATED PLUG VALVES
1/4 turn to open
1/4 turn to close
GENERAL APPLICATIONS: Acids, Alkalies, Condensate, Dyes, Emulsions, Mercury, Mud, Organic Solvents, Pharmaceuticals, Salt Solutions, Slimes, Slurries and Vacuum, in addition to the more general applications of Steam, Oil, Water, and Gas.



To help you "fit the valve to the service" you'll find pertinent information on Walworth's complete line of valves, fittings, pipe, and pipe wrenches in the new Walworth Catalog 42. Included are 78 pages of practical engineering data that simplify valve selection and make piping layouts easier. Write, on business stationery, for your free copy. Address: Walworth Company, 60 East 42nd Street, New York, N. Y. Department 817

Here's a valve that will show substantial savings in maintenance and replacement costs on those tough services where the conventional type of valve doesn't stand up.

Walworth Lubricated Plug Valves are of the plug cock type, using insoluble lubricants. Easy operation, tight sealing, and resistance to corrosion and wear are assured by simply turning down the lubricant screw. Pressure, hydraulically exerted on the entire lubricant system, automatically frees the plug from its seat, coats the finished surfaces with a film of protective non-friction lubricant, and seals the ports against leakage.

Although generally an all-purpose valve, Walworth Lubricated Plug Valves are especially adaptable to "difficult" services. Available in sizes from ½ to 24 inches, for pressures from 125 to 5,000 psi, and for all vacuum requirements. They are designed to help you *fit the valve to the service.*

BOSTON WORKS
KEWANEE WORKS

WALWORTH
valves AND fittings

DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD

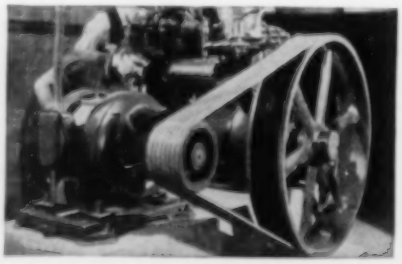
Good Team Great Team

ALLIS-CHALMERS MOTORS AND

☛ Using high-speed motors with Allis-Chalmers Texrope Drives and single-speed motors with Allis-Chalmers Vari-Pitch Sheaves and Speed Changers has always been good practise. *In time of war it's a vital practise!*

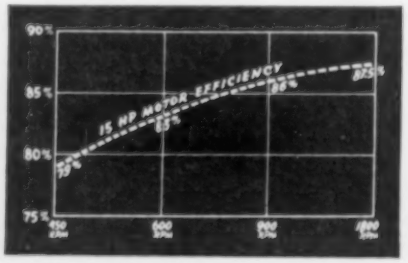
☛ Such combinations give sharply higher efficiencies—at lower cost in man-hours, money and materials!

☛ Allis-Chalmers, only builder of *both* motors and V-belt drives, offers invaluable know-how in teaming them up.



1 In most applications, an 1800 rpm motor with Texrope Drive will ably do the job of a lower-speed, direct-connected motor —at lower cost in money *and materials!*

2 When you buy an 1800 rpm instead of 450 rpm 15 hp squirrel-cage motor, for example, 600 lb are saved. And *you* save well over $200 — with drive figured in!



3 Note that efficiency rises from 79% for the 450 rpm motor to 87.5% for the 1800 rpm motor. The 1800 rpm motor saves you over 30 kw/24 hr. day.

WE WORK FOR VICTORY — WE PLAN FOR PEACE

ALLIS-

in Peace . . . in Wartime!

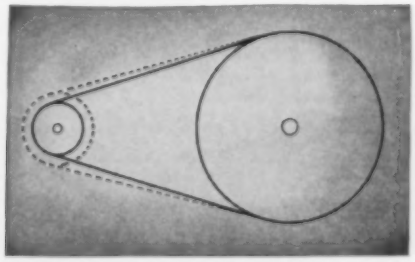
TEXROPE DRIVES

IT'S TIME to take a *fresh* look at motor buying! See below how much you can save with high- and single-speed motors made flexible by Texrope Drives.

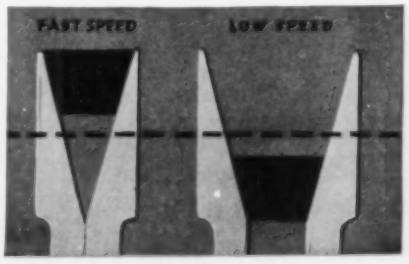
Allis-Chalmers, builder of Lo-Maintenance Motors, originated the multiple V-belt drive and Vari-Pitch Sheaves . . . is the only manufacturer building *both* motors and V-belt drives. You benefit when you ask for — and get — the *right* combination of Lo-Maintenance Motor and Texrope Drive!

Call on your nearby Allis-Chalmers district office for facts, figures and advice — or write direct to ALLIS-CHALMERS MFG. CO., Milwaukee 1, Wis.

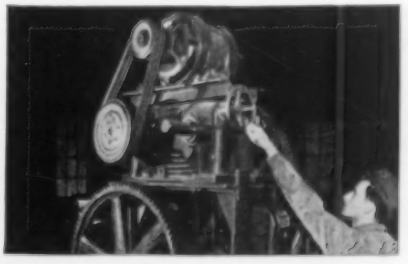
A 1627



4 Infrequently needed speed changes can be had by changing from one size motor sheave to another. Juggling *complete* drives, range is 1:1 to 7:1.



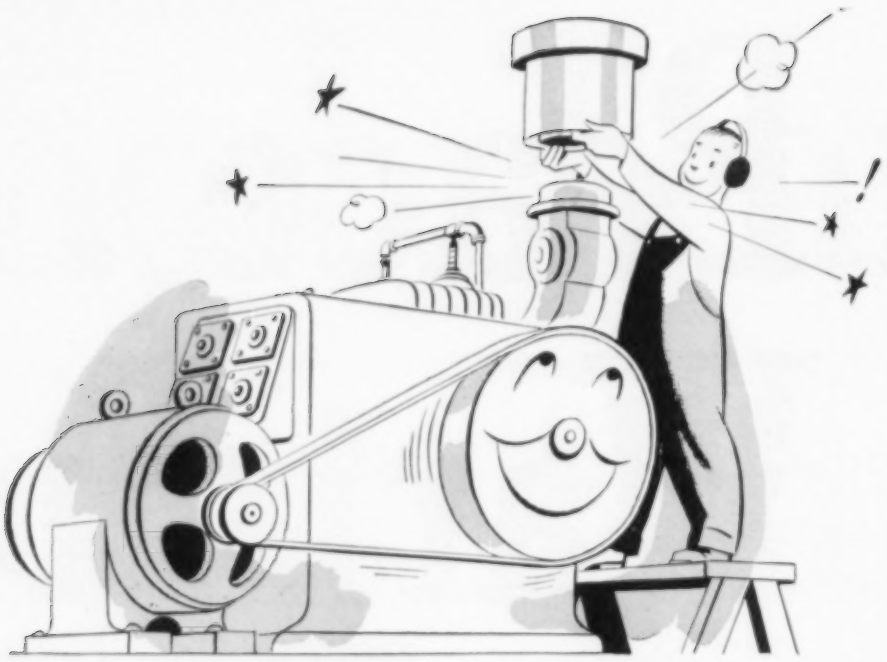
5 With the Allis-Chalmers Vari-Pitch Sheave, you can increase or decrease speed by adjusting sheave diameter . . . obtaining an *unbroken* series of speeds!



6 Allis-Chalmers Vari-Pitch Speed Changer gives you infinite changes at the turn of a wheel — within 3.75 to 1. It's compact, flexible, *efficient!*

CHALMERS

LO-MAINTENANCE MOTORS
TEXROPE DRIVES



MUZZLES the BITE, MUFFLES the BARK of intake air

Not many engineers let grit-laden air chew up the polished insides of their engines and compressors . . . if they know it.

But the bark of intake air can be as hard on workers as its unfiltered "bite" is on machines.

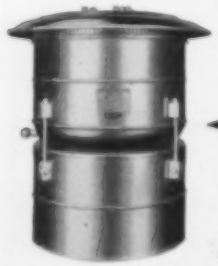
So—why not *muzzle* the bite and *muffle* the bark with a single device?

Where it is desirable to combine the advantages of Air-Maze filters with silencing devices, use Air-Maze filter-silencers. The silencing chamber is designed in proportion to the filter, and consequently to the equipment on which it is installed.

Air-Maze filter-silencers are available in either oil-bath or oil-coated types, featuring the patented Air-Maze crimped, wire mesh media. These permanent, nondeteriorating filters can be kept at their original high efficiency for years, even under severe dust or lint conditions.

Standard Air-Maze filter-silencers cover all common engine and compressor needs. Special sizes can be built to meet any requirements.

For specific recommendations, write, giving full particulars of installation.



Large, oil-bath type Air-Maze filter-silencer. Incoming air flow is reversed and scrubbed by oil before entering the filter media. Silencing chamber is lower portion of unit.

One of over 3,000 types

INTAKE FILTERS TO FIT YOUR NEEDS

OIL-BATH TYPE traps dust most efficiently, due to double filtering action.

MULTIMAZE TYPE —highly efficient, viscous coated element for heavy duty.

UNIMAZE TYPE— used both as spark arrester and intake filter. Has less dust capacity than Multimaze type.

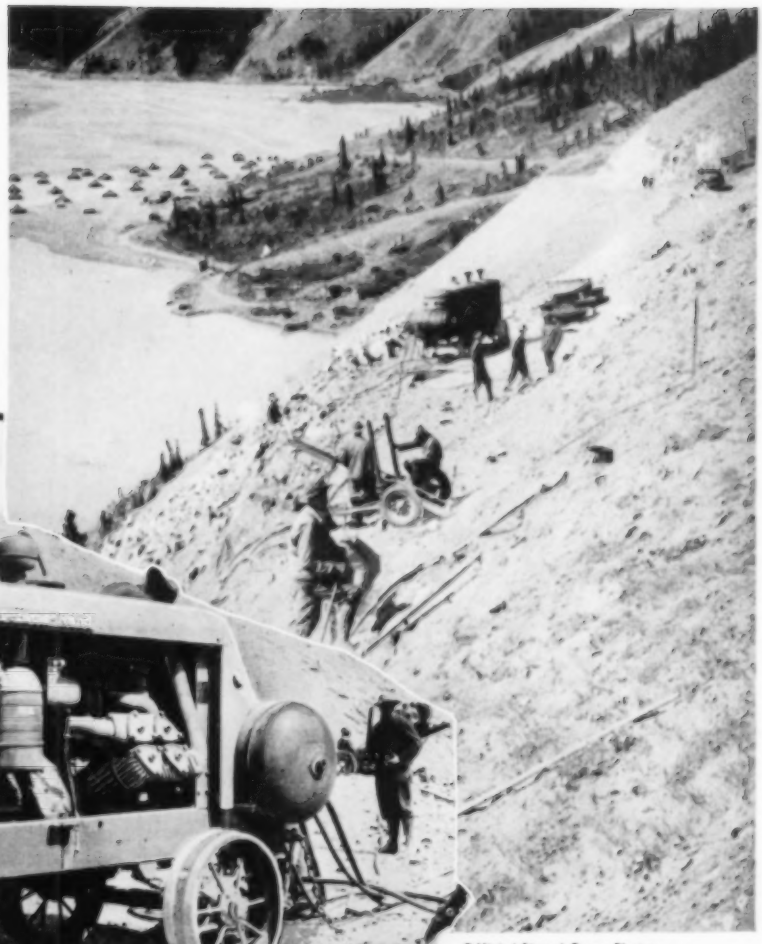
Write for catalog

AIR-MAZE CORPORATION • CLEVELAND, OHIO

AIR-MAZE

SPECIALISTS IN AIR FILTRATION

In this MOBILE WAR-



Official Signal Corps Photos.

Ingersoll-Rand

MOBIL-AIR

AIR POWER

COMPRESSORS and TOOLS

ARE IN THERE FIGHTING!

MOBIL-AIR Compressors and tools are in there fighting! In this war our mechanized fighting forces have been carrying the battle forward a hundred miles in a single day . . . through mountains, deserts, or soggy swamps.

This means roads, bridges, bases, landing fields, gun emplacements, pill boxes, tank traps . . . all to be built or repaired within a miraculously short time.

That is why our Army Engineers are using MOBIL-AIR Portable Compressors and Air Tools in practically all combat, reserve, and supply zones. That is why this same compressed-air equipment is also being used by the armed forces of our allies.

Because these machines frequently operate under fire, they are considered combat units. They must be able to take it, and that is just what they are doing today — from frozen Alaska to the scorching deserts.

Ingersoll-Rand

11 Broadway, New York, N. Y.

2-236

CENTRIFUGAL PUMPS • CONDENSERS • COMPRESSORS • TURBO BLOWERS • ROCK DRILLS • AIR TOOLS • OIL AND GAS ENGINES

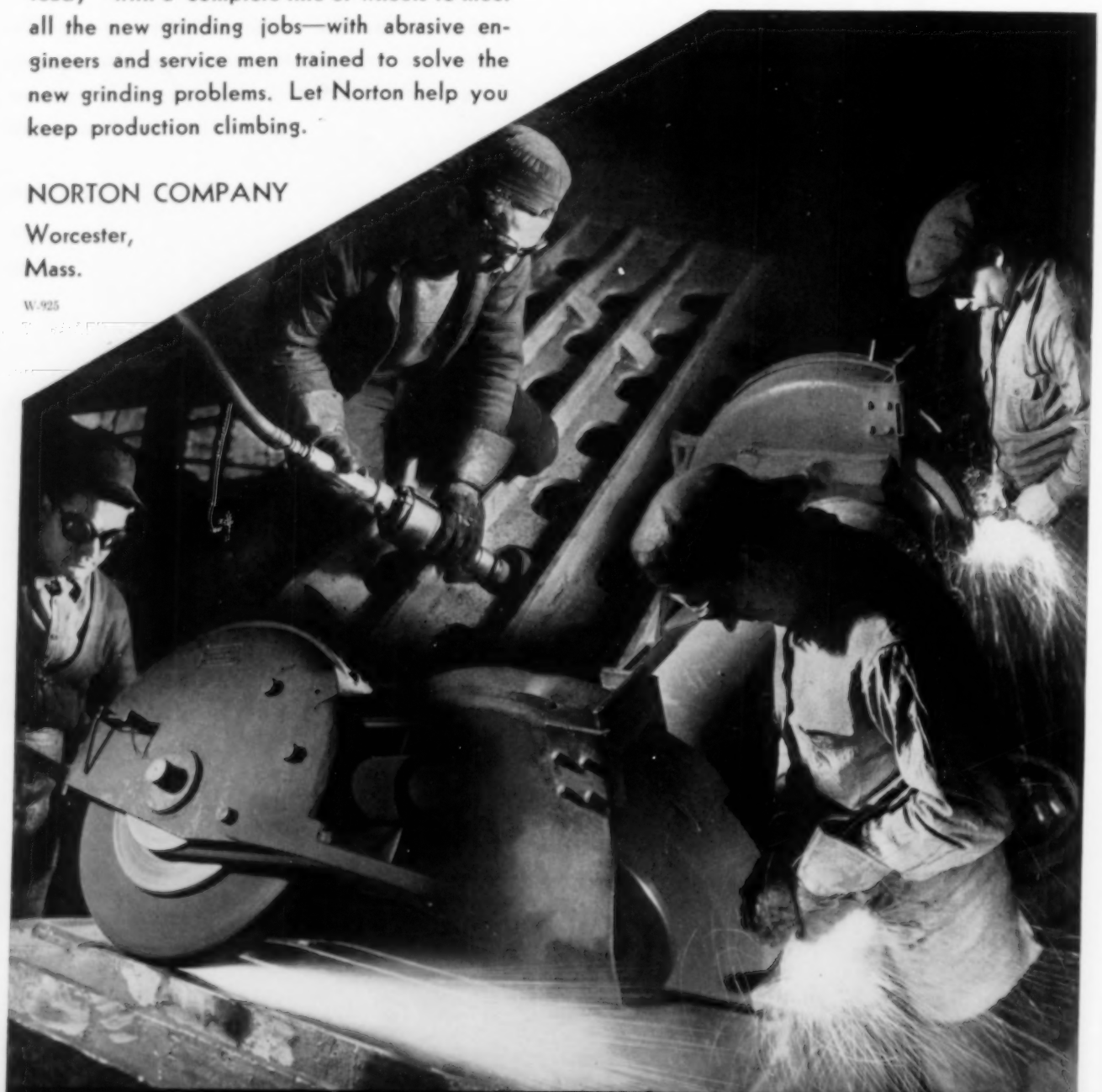
BOOST PRODUCTION

With Norton Grinding Wheels

PRODUCTION curves must go up. War work is bringing new jobs—new grinding problems to many plants. But Norton is ready—with a complete line of wheels to meet all the new grinding jobs—with abrasive engineers and service men trained to solve the new grinding problems. Let Norton help you keep production climbing.

NORTON COMPANY
Worcester,
Mass.

W-925



NORTON ABRASIVES

ON THE COVER

OUR cover picture is an artist's conception of an oft-enacted scene in these times. In the gathering dusk, Allied ships spring to the task of fighting off enemy planes. The illustration is a reproduction of a painting by Charles Rosner.

•

IN THIS ISSUE

COMPARATIVELY few persons have seen the metal titanium, because in nature it always exists in combination with other elements. Yet, in such combined forms it is more plentiful than lead or copper. Titanium dioxide is the best white paint pigment known, and it also has numerous other industrial uses. Until shipping space became too scarce to handle it, most of our titanium ore came from India. Now the National Lead Company has developed a large source of supply in a section of New York State that enjoyed a spirited but short-lived iron-mining boom a century ago. The story of this war-born enterprise is told in our leading article.

•

THERE are ten fewer foundries in the United States than there were two years ago (4,802 against 4,812,) but the quantity of castings produced is greater than it was then owing to the impetus of war work. Some small foundries have closed, but most of them have been replaced by new and larger plants. Steel foundries have increased since 1941 from 298 to 334. The heart of a foundry is the cupola, which comes within our field of interest because it utilizes compressed air to support combustion. Three qualified writers have contributed articles on cupola history, characteristics, and operating information.

•

WORKING under fire, U.S. Army Engineers laid more highways on Attu Island in three weeks than the Japanese had built there in eleven months of occupation. Fifteen Engineer units were cited by the War Department for their work on the Alcan Highway. How they prepare the way for combat is told in a brief article.

•

IN THE article *The Wind That Talks*, Charles Huff tells how the radio has supplanted the grapevine as a means of communication on the vast Navajo Indian Reservation in the West. The new system is as mystifying to the red men as the old one was to their white brethren.

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Century-old Iron

POWER LINE, LOADING STATION, AND MILL

Some idea of the quantity of construction materials that had to be trucked into the isolated location is given by the general view at the right showing the mill and associate structures as they appear from an island in Lake Sanford. The crushing plant is at the left, the wet mill is in the center, and the dry mill and boiler house at the right. The structure on the hillside is the concrete reservoir of the water-supply system. To provide power for the operations, a 42-mile, 110,000-volt transmission line was built through the woods from Ticonderoga. A section of it approaching the mill is seen in the picture above. A 32-mile railroad connection with the Delaware & Hudson at North Creek is now being pushed through. Meanwhile, concentrates are being trucked to North Creek and loaded into railroad cars at the station shown at the top.

MORE than a century ago, pioneer mining men opened up iron ores in a remote section of the Adirondack Mountains in northern New York, near the headwaters of the Hudson River. For two decades they worked the deposits with considerable success, and they had visions of establishing a vast empire of iron. But Nature and fate contrived to throw in their way numerous obstacles that eventually forced them to suspend operations. After that, save for occasional sporadic activities that came to naught, all efforts to revive the industry failed until two and one-half years ago, when the incidence of war suddenly imparted a new worth to the mineral beds.

The iron ore in that region is peculiar in that it contains a rather high percentage of titanium. This was an unwanted element in former times because there was no known application for it and, moreover, it imparted brittleness to the iron made from the ore. Paradoxically, titanium is now much desired for use in making paint pigments, and it was more the need of it than of the iron that brought about the mining revival. Until the war broke out, we were getting all the titanium we wanted from abroad, chiefly from India, which sent us an average of 250,000 tons of ore annually in recent years. When this source of supply was cut off, it became necessary to develop additional domestic titanium deposits in order to supplement the rather meager output of Virginia, Arkansas, and lesser producing states.

Spurred by this wartime demand, the National Lead Company has reopened the Adirondack titaniferous iron ores. From a mountainside on the east shore of Lake Sanford, in Essex County, its Titanium Division is removing 3,500 tons of ore daily and treating it in a newly erected modern mill to extract the titanium-bearing mineral ilmenite by a process that also yields magnetite iron ore as a coproduct. For the present, the ilmenite and magnetite concentrates are being trucked 32 miles to the nearest railhead at North Creek and there reloaded for transshipment to points where further processing is done. Meanwhile, a railroad connection is being constructed to the property, and a sintering plant is being built there. When these two structures have been completed, the output of crude ore will be increased to 4,000 tons daily and the iron will be sintered before being sent to the blast furnaces and steel mills where it is used.

PIGMENT SYMBOL

The National Lead Company markets its titanium pigments under the trade mark at the right. There are numerous grades of Titanox, ranging from almost pure titanium dioxide to compounds containing up to 30 per cent of additives. Although their greatest use is in paint, these titanium preparations impart opacity to paper, and their application for that purpose is expanding now that lighter-weight sheets are being widely employed by publishers to cut down paper consumption in compliance with governmental regulations.

Workings Now Yield Titanium

C. H. Vivian

The titanium concentrates will, as now, be shipped to National Lead Company refineries at Sayreville, N.J., and St. Louis, Mo.

Although it is comparatively little known to the layman, titanium is by no means a rare element, ranking ninth in abundance among the elements of the earth's crust and being more plentiful than lead, copper, or zinc. However, the titanium is generally widely diffused throughout the soil and rocks and seldom is found in concentrations of commercial importance. Ilmenite, rutile, and titaniferous magnetite are its chief sources. In Ceylon and at Travancore, India, ilmenite is recovered as a by-product from monazite beach sands. Wave action effects a rather good separation of them, and this is augmented by hand sorting by natives and, in some cases, by mechanical concentration.

When pure, titanium is a silver-white metal with a fracture similar to steel. It is hard and brittle when cold, but malleable when heated and can be forged like iron. The element was discovered in Cornwall in 1789 by Rev. William Gregor and called menaccanite. A few years later, the German chemist Klaproth also discovered it while investigating rutile. Because of the strength of the chemical combination in which it was held he named it titanium, an allusion to the Titans of Greek mythology who were known for their strength. Owing to its great affinity for oxygen, carbon, and nitrogen, great difficulty was experienced in attempting to isolate the metal until Hunter succeeded in obtaining it in pure form in 1910. The mineral ilmenite, with which we are concerned here, derives its name from its occurrence in the Ilmen Mountains in the southern Urals.

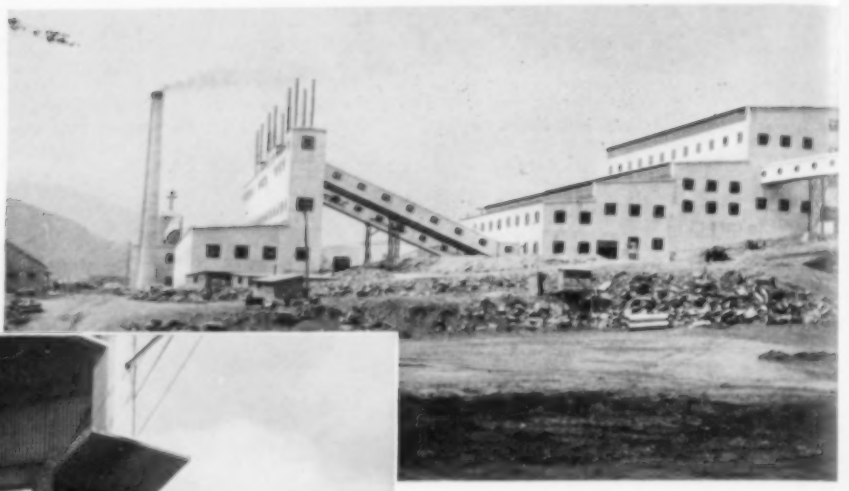
Titanium oxide, which is also called titanium white, is a white paint pigment of exceptional body and covering power, exceeding white lead, zinc oxide, or lithopone in these respects. It has high opacity and, owing to its chemical inertness, is unaffected by atmospheric conditions. The National Lead Company has long been one of the leading producers of titanium oxide, and in normal times approximately 70 per cent of it enters into paints, with most of the remainder being utilized in making white rubber and paper. At present, a higher proportion of the output is being used to manufacture paints.

The huge Lake Sanford enterprise, which involves the expenditure of several million dollars, has been built up from scratch in 30 months—in fact, mining and milling began fourteen months after ground was broken. This was fast time, considering that the access roadway had to be improved and 8 miles of it rebuilt, housing accommodations provided for several hundred men, power lines erected, water systems built, and all machinery and materials of construction trucked more than 30 miles to the site. The company acquired the land in January, 1941, prospected the deposit by means of 70 diamond-drill holes totaling 11,000 feet in length, and had work underway on a 4-unit mill by the following June. The first unit of the mill was started up on July 15, 1942, and the fourth unit went into service last October.

The pioneer mine operators in the Lake Sanford district were Archibald MacIntyre, his brother-in-law Duncan McMartin, Jr., and his son-in-law David Henderson. MacIntyre was state comptroller of New York from 1806 to 1821 and held other public offices, while McMartin served as judge of the old Common Pleas Court and was a member of the state assembly from 1819 to 1830. MacIntyre seems to have acquired an early interest in metals, and around 1825 conducted an unsuccessful iron-mining venture at North Elba, near the head of the Ausable River. He was visited there by McMartin, who was

MILL VIEWS

Ore trucked from the surface mine is crushed and then treated by gravity and magnetic-separation processes, yielding magnetite and ilmenite concentrates. The view below shows a Euclid 15-ton truck dumping its load into the feeder for the primary crusher. The boiler house and a section of the mill are seen at the right.



assisting in the Adirondack land survey. It was generally believed at that time that the Indians had knowledge of silver deposits but would not reveal their locations, and MacIntyre asked McMartin to be on the lookout for silver and other metals while engaged in his survey work.

In the autumn of 1826, McMartin and a party that included Henderson and MacIntyre's son John, were exploring the region around North Elba when they met an Indian named Lewis Elija who displayed a piece of magnetite. In return for "dollar, half, and 'bacco," he agreed to lead them to its source. Following him, they eventually arrived at the north end of Lake Sanford and were shown an outcrop of the ore. The party took samples, returned to North Elba to give them to MacIntyre, and then hurried to Albany to file on the claims. MacIntyre and McMartin immediately started buying land in the vicinity of the deposit, and they eventually owned a tract of 105,000 acres for which they had paid ten cents an acre. This was in a wild, inaccessible area that comparatively few white men had visited and that was marked on the early maps as Conchsachrage, one of the four beaver-hunting grounds of the Six Nations.

In the face of great difficulties, a road was built from Lake Champlain, and in 1830 six tons of ore was hauled out and tested in a charcoal furnace. The iron obtained from it appeared to be satisfactory, and development work was continued. McMartin died in 1837, having previously transferred his interest to MacIntyre. The latter passed some of the holdings on to Henderson, who thereupon became the guiding spirit of the enterprise. In 1838 a blast furnace was constructed, and in 1839 the Adirondac Iron & Steel Company was incorporated to make "bar iron, anchors, mill irons, chains, steel, sheet iron, nail rods, spikes, bolts, and iron mongery." Its capitalization was $1,000,000.

Although Henderson was accidentally killed in 1845, the momentum that he had given the venture continued to carry it on for several years more. In 1848 the Adirondack Steel Manufacturing Company was formed and a $100,000 steel plant was built in Jersey City, N.J. It had a capacity of 2 tons a day of what has been claimed to be the first steel made in this country. Using iron ore that came exclusively from the company's mine, the mill operated successfully for several years, and some of its product was awarded a gold medal at the World's Fair in London in 1851.

The mining activities were meanwhile being expanded and a new blast furnace was constructed in 1854. It was 36 feet square at ground level, 48 feet high, and had a capacity of 14 tons a day. Combustion air was supplied by four cast-iron blowing cylinders of 5,000 cfm. capacity. A sizable village, known both as MacIntyre and Sanford, had grown up adjacent to the mine workings and was important enough to support a bank. At the south end of the lake, 11 miles distant, a dam had been built to raise the level of the lake for water transportation, and nearby was the community of Tahawus where a sawmill and other structures were located. These settlements at the two ends of the lake were known, respectively, as the upper and lower works.

In 1856 floods destroyed the dam at Tahawus, and the panic of the following year added to the difficulties of maintaining operations. Still another blow fell with the death of Archibald MacIntyre in 1858. Left without a responsible head, the company abruptly ceased all activity. Within a short time everyone had left the section except a caretaker, and Adirondac became known as the "Deserted Village." It was, perhaps, the nation's first "ghost" mining camp.

During the succeeding years various futile attempts were made to reopen the deposits. Lack of a railroad was a serious handicap, and several ineffectual efforts were made to provide one. In 1897 the Forest Preserve Board condemned much of the land that offered the only direct rail route and included it in the Adirondack Park. In an effort to obtain a right of way before this movement was completed, the Adirondack Railway Company was hastily organized and filed condemnation papers on the same day the state took action. This precipitated a controversy which the courts subsequently decided in favor of the state. The creation of the park ended all chance of a direct railroad, but in 1905 an effort was made to build a line that would avoid the state preserve.

At that time the administration of the affairs of the mining company was in the hands of Wallace T. Foote, Jr., a member of a family that long had been identified with the mining of iron-ore deposits adjacent to Lake Champlain. With a view to reopening the Lake Sanford deposits, Foote conducted diamond-drill explorations of the ore beds and also made surveys for a railroad from

SITE OF THE MINE

The area from which ore is now being taken was heavily wooded. The view at the left was taken in June, 1941, while clearing was in progress. A section of the hillside of ore, with one of the benches started, appears just below. Two of the electric loading shovels are shown at the bottom, with the mill in the background.

Ticonderoga to Lake Sanford over a route that skirted the park. Although the railway was never built, sections of the route were followed by National Lead Company in erecting the transmission line that furnishes power for current operations.

The death of Foote in 1910 put an end to all revival hopes for the time being, but three years later new efforts were made. For some years previously, iron technologists had contended that the high percentage of titanium in the ore would prevent its satisfactory reduction. To settle this point, arrangements were concluded in 1913 to make tests. A blast furnace at Port Henry, N.Y., was leased for six months and a crew of men was sent to Lake Sanford to mine sufficient ore for the purpose. A small village was built to accommodate them, and a magnetic separator was set up to concentrate the ore. The concentrates were hauled to North Creek in the winter on 52 sleds drawn by logging locomotives, and additional crude ore was transported overland to Port Henry by horse-drawn sleds. The blast-furnace tests were reported as satisfactory, but nothing further transpired to bring the Lake Sanford district back to life. One important reason for this was undoubtedly the fact that ample iron ore for the American steel industry was coming from the Lake Superior ranges at prices too low to permit competition by mines that were so far from railroad- or water-transport facilities.

Meanwhile, it had been recognized that the ores constituted an important source of titanium. As early as 1890, when James MacNaughton, a grandson of Archibald MacIntyre, was in charge of the holdings, Dr. A. J. Rossi, a young French chemist who was interested in titanium, had been engaged to conduct experiments. He succeeded in smelting the ore in a small blast furnace in Buffalo, and also produced various alloys of titanium. In the course of his investigations he discovered the fact that titanium was suitable for use as a paint pigment.

Doctor Rossi's work laid the foundation for the formation of two companies. One of them, the Titanium Alloy Manufacturing Company, produces ferrocarbon titanium for use in purifying steel. The second firm was the Titanium Pigment Company, forerunner of the Titanium Division of the National Lead Company. Thus one of the concerns that Doctor Rossi helped to found is now exploiting the ores with which he made his experiments. In deference to the pioneers who struggled courageously but vainly to establish a successful iron-mining industry at Lake Sanford, the National Lead Company calls its operations there the MacIntyre Development.

After mining ceased, the area around Lake Sanford reverted largely to the wilderness. There were few settlers, and no industrial activity other than some scattered logging operations. Almost the only visitors were naturalists and sportsmen. The MacIntyre holdings were leased to a succession of clubs conducted for the benefit of such persons, and it was because of their existence that the region figured in an incident of national interest in September, 1901. Mrs. Theodore Roosevelt, wife of the vice-president, was spending the month vacationing at the Tahawus Club, and Mr. Roosevelt arrived there on the

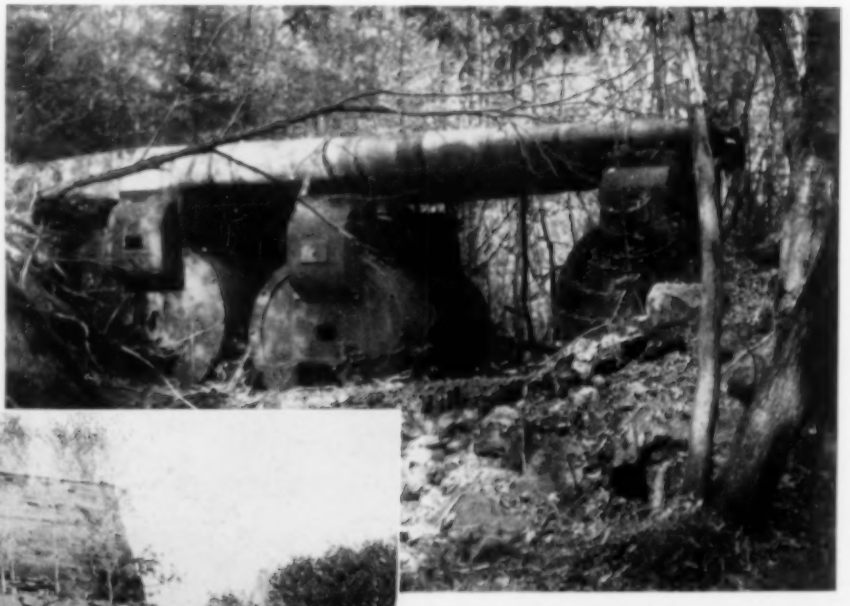
eleventh to join her. He had come from Buffalo, where President William McKinley was apparently recovering from the effects of an assassin's bullet. Mr. Roosevelt set out from the club on the twelfth for Lake Colden and on the following day climbed Mount Marcy, the state's highest peak, reaching the summit in three hours. On his way down he was met by a guide, who bore the news that McKinley's condition was worse and that Roosevelt was wanted in Buffalo. Roosevelt arrived at the clubhouse at 5:15 and left at midnight for North Creek, where a special train was waiting. Three drivers, working in relays, drove him as fast as their horses could travel, but McKinley died while he was en route. A bronze marker alongside the highway, not far from the present Aiden Lair Lodge, records the fact that Theodore Roosevelt became president at about that spot at 2:15 a.m. on September 14,1901.

The MacIntyre tract had dwindled to approximately 11,000 acres—less than one-tenth its original size—at the time the National Lead Company purchased it in 1941, but it was still held largely by descendants of the pioneer iron producers. The deposit now being mined is not the one previously worked, but is on the east side of Lake Sanford and 6 miles above Tahawus, where the "lower works" of the MacIntyre operations were located. It consists of irregular masses of fine-grained ilmenite and magnetite distributed throughout a dark-colored intrusive rock called anorthosite.

The ore body lies on a steeply sloping hill that rises to a height of 350 feet and also presumably extends underneath the lake, although no prospect holes have been drilled there. The area being worked is roughly circular in surface outline and about 2,000 feet in diameter. It is being developed by means of benches at vertical intervals of 35 feet, and there will be eight of these when it is fully opened. These benches are extended at a rate of 40 feet daily. After the shallow overburden has been removed by means of a scraper powered by an electric hoist, the initial drilling is done with an Ingersoll-Rand DA-35 drifter drill mounted on a tripod. Approximately horizontal holes, 16 feet deep, are drilled into the hillside. After these are fired, the muck is loaded into trucks by a small power shovel.

On the level strip created by this preliminary work, a Bucyrus-Erie 29-T well drill is set up. It puts down 40-foot holes on 18-foot centers, employing a 6⅝-inch bit which makes a hole 7 inches in diameter. Each of these is loaded to within 13 feet of the top with 350 pounds of 60 per cent dynamite in 5x24-inch cartridges. The blasted material is loaded into trucks by 2½-yard electric power shovels. There are eight of the latter in service—six Euclid 15-ton units and two 28-ton Macks. Where rock is admixed with the ore, a selection is made with the shovel. The ore is hauled to the mill, while the rock is disposed of at the ends of the benches. When a bench has been cleaned up, it is usually found that some material at the base of the vertical face rising to the next bench above has not been shot out. To remove this, Ingersoll-Rand FM-2 wagon drills put in toe holes spaced 6 feet apart laterally and 3 feet vertically. Jackbits are used for this purpose and for the small-hole drilling when the benches are started.

Test drilling indicates that there are approximately 15,000,000 tons of ore in the deposit and that it averages 16 per cent titanium oxide and 35 per cent iron. The recoverable titanium content will supply the nation's pigment industry for approximately ten years. Other ore bodies remain to be exploited after this one has been worked out. The ilmenite and magnetite are fortunately bonded together only mechanically, and this makes it possible to separate them from each other and from the accompanying rock by grinding the mixture to a fineness that will pass through a 20-mesh screen. The mill, of which the only similar one is in Norway, was designed by Archer E. Wheeler of New York. The process combines the principles of gravity and magnetic separation. The crude ore first passes through a crushing plant, where it is reduced in three stages to minus ½-inch size. In the first stage, it is fed by means of a Ross feeder to a 48x60-inch Buchanan-Birdsboro jaw crusher. Then it goes in turn to a Symons standard cone crusher



RELICS OF THE PAST

The pioneers who first mined ores at Lake Sanford for their iron content erected two blast furnaces, one in 1838 and another in 1854. The upper part of the masonry of the latter structure is shown at the left. A water-wheel-operated blowing engine of 5,000-cfm. capacity furnished compressed air for this furnace. The remains of three of its four cast-iron cylinders, with the overhead delivery pipe in place, are pictured above.

and to a Symons shorthead cone crusher, having screens and conveyors arranged in a closed circuit to provide a final product of the desired size.

The crushed material is elevated by belt conveyor to bins at the top of the adjacent mill building. From the bins it is fed to four rod mills that operate in a closed circuit with vibrating screens, and it is there ground to minus 20 mesh. Water is added to this finely divided material in the proportion of two parts water to one part solid, and this is passed through Crockett wet-belt separators, of which there are twelve. The fact that both magnetite and ilmenite are magnetic, but in differing degrees, makes it possible to separate them. The first step is to pick up both minerals by high-intensity magnets, most of the gangue being dropped out. Then, by utilizing lower-intensity magnets in the second and third stages, the slightly magnetic ilmenite is dropped while the magnetite is attracted and carried on. After being dewatered, the magnetite concentrates are ready for shipment.

The first separation from the Crockett separators containing the ilmenite, extraneous gangue minerals, and water, is sent to Fahrenwald classifiers, where it is sized and discharged as coarse sands, fine sands, and slimes. The first two are passed over Deister Plato-O gravity concentration tables which yield rough ilmenite concentrates. There are 96 of these tables. The slimes go to hydroseparators, where the coarse matter is segregated and sent over the Deister tables while the fine material is wasted. The ilmenite concentrates produced by the tables are dewatered in Allen cones and Dorrco filters and undergo further moisture reduction in steam-coil driers. The steam for this purpose is supplied by two 500-hp. boilers. The dried material is treated in Wetherill high-intensity, dry magnetic separators for the extraction of the ilmenite.

When treating 4,000 tons of ore daily, the mill will produce 600 tons of ilmenite concentrate containing approximately 46 per cent of titanium oxide, and 1,300 tons of magnetite containing 57 per cent of iron. The magnetite has a titanium-oxide content of about 9 per cent, and also contains about 0.7 per cent of vanadium oxide. As vanadium is in great demand right now as an alloying element for steel, research is being conducted looking towards the recovery of this important metal. Both the magnetite and ilmenite concentrates are now being trucked to North Creek under contract by J. Mosher. Meanwhile, S.A. Scullen, of Albany, N.Y., is pushing work on the railroad connection to the property and expects to have it completed before next winter sets in. This connection, which is being financed by the Defense Plant Corporation, joins with the Delaware & Hudson system at North Creek and will be operated by that road for the National Lead Company as lessee.

HISTORIC BRIDGE

This iron structure, probably a century old, spanned the headwaters of the Hudson River below Lake Sanford. Supports were placed under it, as shown here, to permit heavy loads to be hauled over it during the mill-construction period. The span was afterwards removed when the road was rebuilt, being replaced by a concrete bridge farther downstream.

In order to get the mine and mill into operation, much auxiliary work had to be done. The task of stringing the 110,000-volt transmission line from Ticonderoga was a prodigious feat in itself. A right of way 100 feet wide and 42 miles long was literally cut through the forest, and on it were erected 494 towers, each made up of two or three western red-cedar poles ranging from 45 to 75 feet in length. On them was strung 137 miles of 7-strand copper wire to carry the 5,000 kilowatts of power required at the mine and mill. Work was started on this line in August, 1941, and completed in February, 1942. Much of the time the construction crew put in only four hours of effective labor a day, as the remainder of its shift was spent in traveling to and from the scene of operations.

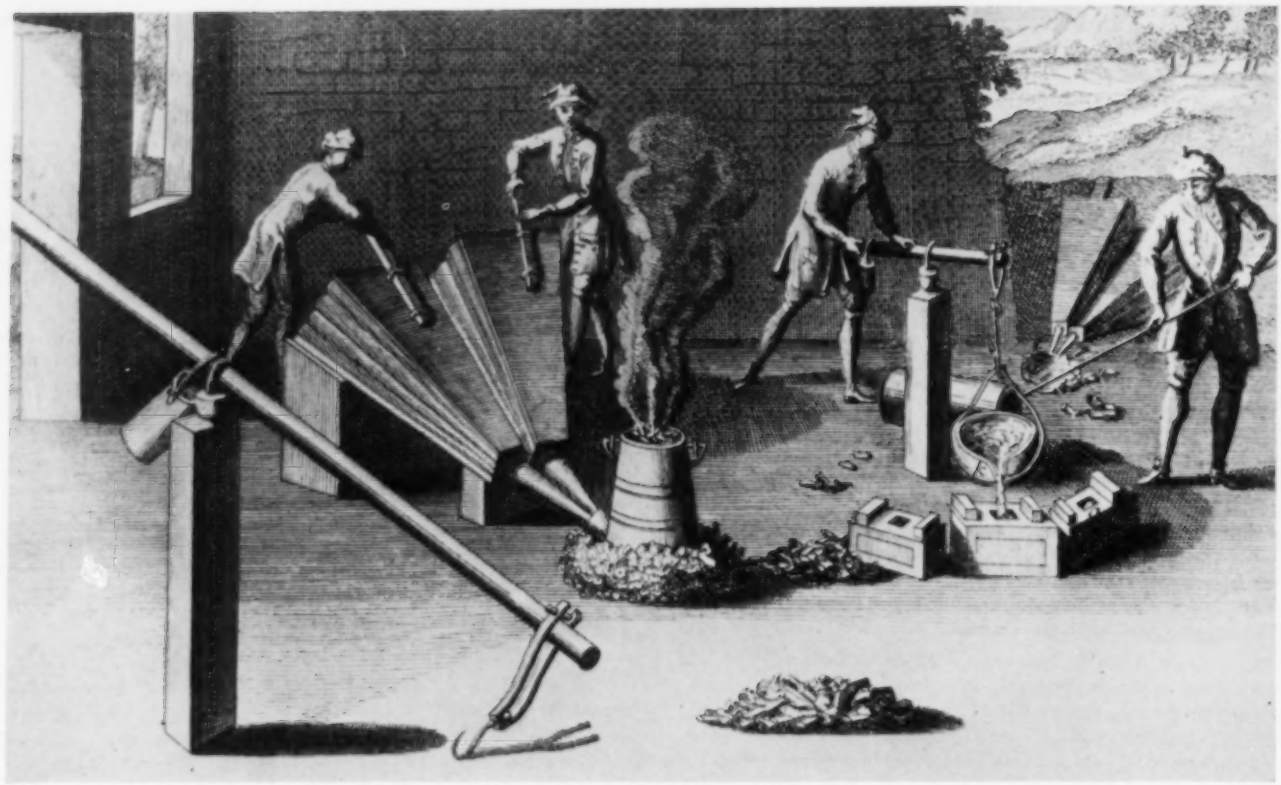
Another sizable ancillary job was that of supplying water to meet the requirements of the mill and the community. A reservoir of 750,000 gallons capacity was built on top of a nearby hill to serve the mill, and a second one of 350,000 gallons capacity with a water-treatment plant was provided for domestic purposes. Water for both systems is pumped from Lake Sanford by two 5,000-gpm. pumps. For the accommodation of the workmen and their families was constructed a complete village including 58 houses and apartments for married men, dormitories for single men, a recreation hall, garage, fire-fighting equipment, and numerous other adjuncts of a modern community. This village is adjacent to the post office of Tahawus, which has been moved several miles upstream to bring it nearer to the operations.

Although titanium oxide is the whitest paint pigment known, the ilmenite from which it comes is black and the process of transforming the concentrate into the final product is an involved one. During the many years it has been engaged in this work, the National Lead Company's Titanium Division has developed a highly efficient operating technique. Some 1,600 employees are occupied in the manufacture of its Titanox pigments.

Because the MacIntyre Development was of great importance to the Government as a source of raw material for pigments needed to make paint for naval vessels and other war purposes, there was assigned to the project the highest priority rating that had been given up to that time for any undertaking other than armament production. It is expected, however, that the enterprise will be an enduring one, as iron, titanium, and vanadium are all vital to the national economy in peacetime. Although the Government was directly interested in the consummation of the MacIntyre Development, the only funds made available for it by a Federal agency were those advanced for the building of the railroad to the property and for erecting the sintering plant. All other financing was done by the National Lead Company.

I. D. Hagar, assistant manager of the Titanium Division of the National Lead Company, is general manager of the Lake Sanford operation. Otto Harries is resident manager and F.R. Milliken is his assistant. C.R. Begor is mine superintendent and L. S. Taylor is mill superintendent.

• • • THE FOUNDRY CUPOLA • • •



REAUMUR'S CUPOLA

The French scientist, Rene Reaumur, was awarded a pension of 12,000 livres for his researches in iron and steel, which included the invention of the cupola in 1722. As shown here, it was a small affair, blown with air supplied by hand bellows. The word "cupola" comes from the Latin for "tub" for reasons made plain by an inspection of this picture.

History

*J. R. Loss**

IN THESE days of shortages, bottlenecks, and scarcities of materials and machines, one hears very little mention of the gray-iron foundry industry. That it is doing its share in the war effort is evidenced by the large number of iron castings used in making all types of machinery. Penton's Handbook for 1943 lists more than 5,000 cupolas in the United States. Assuming for them an average hourly capacity of 10 tons and and average daily service of six hours, their annual melting capacity totals 90,000,000 tons, as compared with about 80,000,000 tons of pig iron produced by the nation's blast furnaces. This is a purely theoretical figure, as the actual yearly cupola output is probably around 15,000,000 tons.

The melting unit—the cupola—is veritably the heart of the foundry, and one reason for the industry's excellent position is the great improvements the cupola has undergone in recent years. The progress achieved along this line in the past quarter-century exceeds that made during the previous 300 years. Before discussing these improvements, let us briefly review the history of the melting of metal.**

Some of the earliest references to iron-casting concern statuary.*** The ancient Greeks practiced this art, which was copied by the Romans, and which the Chinese engaged in at an early date. In the Field Museum of Natural History in Chicago, Ill., there are examples of such work from the Han dynasty (206 B.C.–220 A.D.) The methods and the melting units employed, and other details of the processes, are not recorded. However, extant cast-iron statuary of those periods give evidence of their effectiveness.

It is apparent that the Chinese did more image-molding than any other race. From the time of Buddha they reproduced in cast iron numerous religious objects, examples of which are on exhibition in museums in many parts of the world. While an iron casting made before 500 A.D. is a rarity, it is noteworthy that numerous bronze castings bearing earlier dates are in existence. However, proof of the fact that iron in this form was used before the Christian era is contained in Tso Chuan, which was written in the third century B.C. It states that 650 pounds of iron was required to cast the tripod on which the criminal code was inscribed. Scientists agree that this is the first reference to cast iron so far found in Chinese literature; and the use to which the casting was put is noteworthy.

An interesting point about the ancient Chinese iron castings is that they seem to have been produced soon after the art of casting bronze was developed. Elsewhere in the world there have been discovered bronze castings that are 3,000 and more years older than the earliest-known iron castings made in the same regions. The probable explanation is that the techniques practiced there lent themselves to the melting and casting of bronze but not to the melting and casting of iron.

According to a Japanese treatise on cast iron, a Chinese master of casting

*War Production Board
**Sources of information, "Principles of Iron Founding" by Dr. Richard Moldenke and books on foundry practice by West and Kirk.
***George F. Mullan, article in "Canada's Foundry Journal," June, 1942.

visited Japan during the Kamakura period (A.D. 1270) and taught the art in many parts of the country. For several centuries the Japanese apparently used cast iron chiefly for the making of iron kettles, notably the Nambu variety in the Morioka and Sendi districts. These kettles are still produced, but with the aid of power-operated machinery.

Charcoal appears to have been employed as fuel in the ancient days of metal-melting, except in China, where coal seemingly furnished the heat. Wherever charcoal was relied upon, the fuel consumption was so high that it probably resulted in a material that was more expensive than bronze, and there was consequently no incentive to make castings of that metal. It is interesting to note that even in the "dark ages" of the foundry, fuel consumption was an important item in the industry.

The early history of the foundry cupola is obscure, all the more so because the latter has been confused with the shaft furnace that was used for the smelting of iron ores. Until the nineteenth century, metal cast directly from the blast furnace entered into all commercial work produced in quantity. The first castings were made for stoves, the oldest example of a complete cast-iron stove dating back to the year 1500. It reposed for years in the fortress at Coburg, Germany, and possibly still does, unless it has been removed for safekeeping since the outbreak of the war. In England there are records of a very fine plate cast by Ironmaster Richard Lennard at Drede Fournes, Sussex, in 1636. Apparently it was used for advertising purposes, since it shows the founder holding his sledge and surrounded by other evidences of his art.

In the United States, as elsewhere, castings were originally made direct from blast furnaces, and it is worth mentioning that the first furnace of this type was built in Lynn, Mass., in 1645. By 1720 the iron industry was pretty well established in this country, and by 1750 blast furnaces were to be found here and there throughout Pennsylvania. In spite of this, the farmers of those regions imported their stove plates from Germany and Switzerland. When the castings wore, cracked, or proved otherwise unsuitable, their owners took them to the nearest furnace for recasting, thus putting the early American ironmasters in the business of making stoves and doing general casting work. The first American cast-iron stove dates back to 1756, and, so far as we know, the first remelting of iron in a cupola (without any ore admixture) in the United States occurred in Pennsylvania about 1820. Pots, kettles, cauldrons, flatirons, bake pans, and andirons were the most common articles made by foundries in those days.

European records of cupola melting go back to 1722. Reaumur had a little portable cupola 16 to 24 inches high and 6 to 9 inches in diameter. It was operated by a hand bellows and was made in two sections, the lower for collecting the metal and the upper serving as a stack or chimney. It is interesting to compare this with a modern cupola having an outside diameter of 120 inches, standing 60 feet above the floor, and provided with a 250-hp. blower.

Reaumur built a number of cupolas having a skeleton work of iron filled out with fire clay. The advantages of the cupola soon became apparent, and its development was rapid. In England, in 1794, a patent was granted to John Wilkinson for a design that closely approaches that of the modern cupola, and it was used extensively for many years. Wilkinson was one of the first to eliminate the blast furnace as a source of metal and to utilize the cupola instead.

The early cupola must have been a crude affair, but its use seems to have been fairly well understood. In support of this, J. H. Every of Lewes, England, reports that his grandfather, in 1832 or thereabouts, melted iron in a hogshead lined with brick and clay and obtained power for the fan by driving a horse around the usual circle. We must assume that the air was controlled by changing the horse's rate of travel, with oats, perhaps, serving as a persuader. There are also numerous records of foundries and of cupola operations on the continent. Probably the most famous of such establishments was that of the Schneider Works in France.

So we find that the foundry, in all parts of the world, was developing along two lines—providing metal either direct from the blast furnace or indirectly from the cupola. However, with the approach of the steam age, it was obvious that complete dependence could not be placed upon engine and machinery castings made by the direct method and that the remelting of pig iron was essential. This has since become a business in itself. Thus the foundry assumed the proportions of a well-rooted industry, establishing itself as an adjunct to machine shops. Its separation from the blast furnace was a slow process, and for years the two worked side by side producing castings for the trade. Even today, in a few isolated cases, we find blast furnaces making castings direct. These exceptions are steel mills that make it a practice to cast their own ingot molds and maintenance equipment with molten pig iron that is tapped directly from the blast furnace.

MOLDED BY TUNG HUNG
An example of Chinese foundry art.

As previously mentioned, the cupola was introduced in Pennsylvania about 1820, and it appeared in New York City a short time later. The well-known J. L. Mott Iron Works commenced operations in 1828 at Mott Haven on the Harlem River, and since there were no blast furnaces in the vicinity, this concern used the cupola for making castings, importing some pig iron from England. Among the early Mott-made castings were pipes and fittings for the old Astor House in down-town New York that was razed in 1913 and for municipal water systems. By that time the art of molding and casting must have been in an advanced stage, for sections of some of those pipes were as little as ⅛ inch in thickness. The cupola was very much in evidence during the Civil War, and produced a large number of cast-iron cannon and cannon balls. The reader may recall a story in this magazine that made reference to an old Manchester, N.H., foundry that cast Civil War cannon.

The development of the cupola has been accompanied by significant changes in the type of products manufactured. During the middle of the nineteenth century, cast iron was cast iron, with no type, grade, or specifications. When the melter was skillful, sound castings resulted. However, tensile strengths of 15,000 pounds per square inch were the average. At present we make uniformly sound castings with strengths as high as 75,000 pounds per square inch. In other words, we can now get some of the physical properties of steel without going through the steelmaking process. Moreover, where cupolas once were limited with respect to size, tonnage, and length of heat, they are not (for all practical purposes) limited as to physical size today. The modern automotive cupola of prewar design has an inside diameter ranging from 60 to 96 inches at the melting zone and a charging door some 20 to 25 feet above the bottom. The refractories used for lining are of such grades that a heat of sixteen hours—producing up to 400 tons of metal—can be run and very little patching will be required for the next heat. Charging is done by mechanical means, and provision is made

for the proper distribution of the complete charge—metal, coke, and flux, in proper order.

In the modern cupola everything is measured and weighed so that all the elements going into the charge are controlled. Even the air is accurately weighed. This is important, because the weight of the air charge is approximately the same as that of the solid charge. For example, a cupola melting 400 tons of metal a day would need about 400 tons of air. Of late, in certain special processes such as the casting of piston rings, the moisture content of the air is also being controlled—maintained at some definite value. Because of the varying controls possible in cupola operation—namely, coke size, metal distribution, metal spacing, charge spacing, air supply, air distribution, heat recovery, etc.—it can easily be realized that the efficiency of the cupola as an energy converter varies on a thermal basis from 20 to as high as 65 per cent. This thermal efficiency is reflected not only in fuel consumption, which is of vital importance in these days of all-out production, but in the structure and the fluidity of the metal.

Today's Cupola

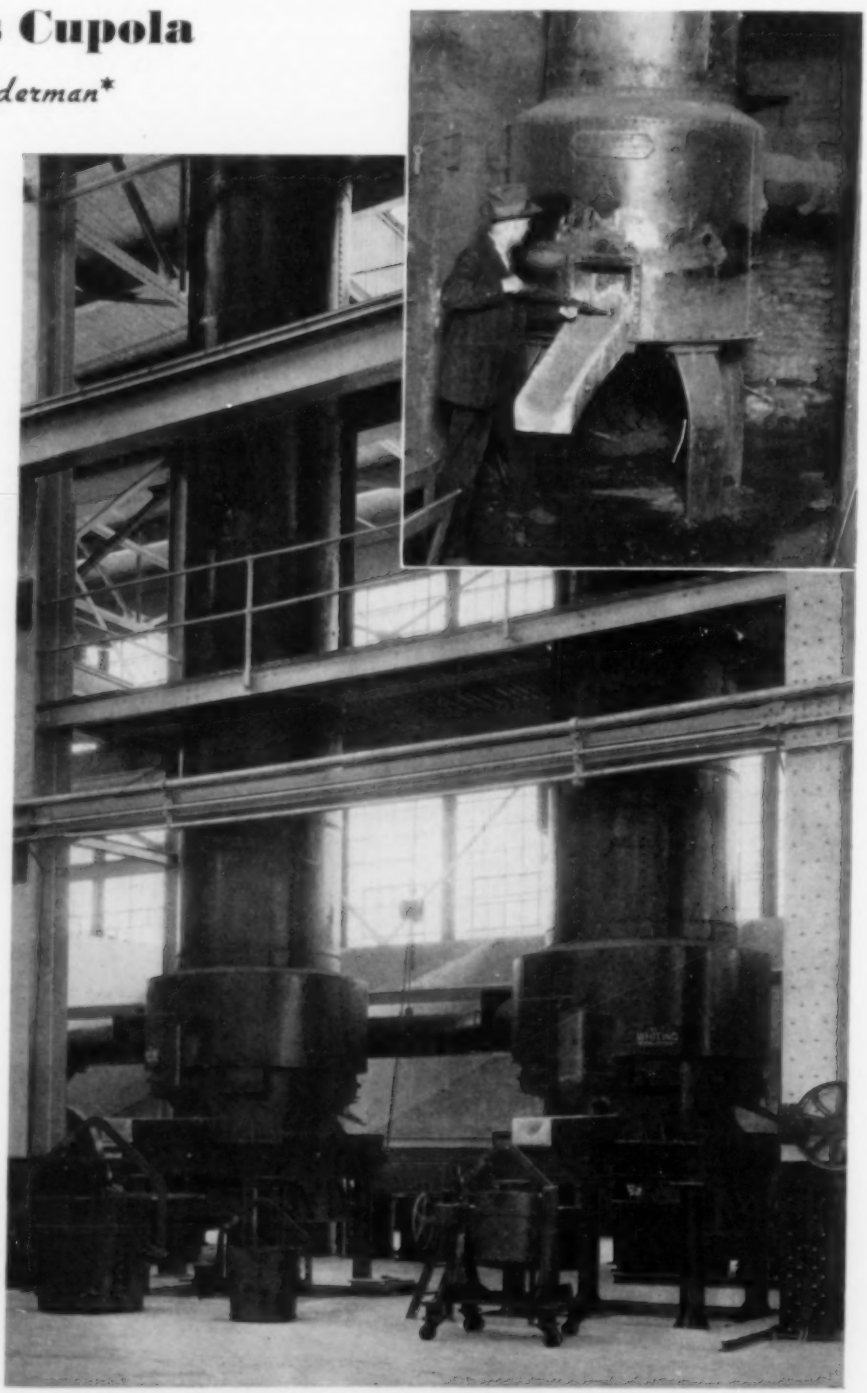
*D. Polderman**

THE first Whiting cupola was built in 1884, and the design was so sound in every respect that basic improvements in the furnace itself have been few and far between. Today's cupola, however, has many features which make for ease of operation and control and which insure more uniform composition of the iron at lower production cost. Perhaps the most important improvement is the higher wind box, now located above the tuyeres, with elbows or downtakes leading from it to the tuyere openings. This has several advantages over the old style, which extended from the base plate to a point well above the tuyere level.

The new type of wind box makes possible a tightly welded construction with no cleanout door and no connection with the base plate, where there was always the danger of leakage. Practically all the old style wind boxes became filled with slag and metal after being in operation a short time. This, of course, is impossible with the elevated wind box. One tuyere is placed slightly lower than the others and has a fusible plug of low melting point on the bottom. If metal or slag rises to the tuyere level, it enters the safety tuyere, the fusible plug melts, and the metal is prevented from reaching the other tuyeres.

Most of the older cupola installations had rather short legs—3½ to 4 feet in length. The advent of the new-type mixing ladle, which is in universal use today, made it necessary to have more headroom. As a result, few of the new cupolas in service have legs less than 6 feet from grade to base plate because the ladle set-up requires that much headroom. Another recent, noteworthy improvement in cupolas is the higher charging door. At one time a distance of 12 to 14 feet from the base plate to the charging-door sill was considered adequate. But this did not permit sufficient preheating of the charging material as it descended from the charging door to the melting zone, and it has therefore been increased to 20–24 feet.

*Vice-president, Whiting Corp., Harvey, Ill.



OLD AND NEW

At the top is a cupola that was installed by the Whiting Corporation in 1884, the first year it was in business. The other picture shows two recently built Whiting cupolas in the foundry of the Canadian National Railway Company.

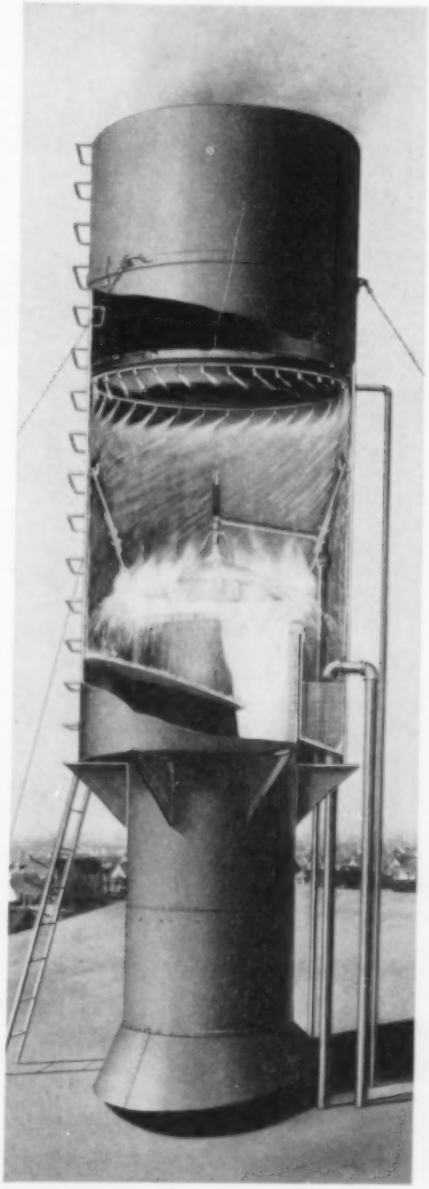
The typical cone spark arrester that was in general use for years served to arrest the heavy particles emerging from the stack, but it failed to collect the smoke and light fly ash and sparks. The new water collectors arrest all these materials, assure a clean roof, and eliminate the fire hazard. They also are a means of effecting a satisfactory blackout, which is important in wartime.

In the old days, all cupolas were charged by hand. The materials were unloaded manually from incoming cars, picked up and dumped into wheelbarrows, carried to the charging floor by an elevator, and then charged into the cupola by hand. Even today, probably 90 per cent of the cupolas in service are charged in this manner, but many mechanical charging systems have been installed in larger foundries with tremendous savings in labor and improvements in cupola operation. One such foundry, which melts about 50 tons per hour, until recently employed eighteen men to charge its cupolas. Today they are being charged mechanically by three men, who have very comfortable and desirable jobs.

Charging the cupola really starts when railroad cars deliver the materials at the foundry. By the most efficient, complete systems, the metallic part of the charge is unloaded by a magnet, and coke and limestone are handled by grab bucket. Coke and stone are dumped into overhead hoppers, from which they are discharged by gravity into charging buckets. The metal charge is made up and delivered by magnet to the buckets—the metal, coke, and stone ordinarily being put in one bucket. From the loading station, the buckets are moved by mechanical means to a pick-up point, where a crane hoists them and delivers the charge inside the cupola. The most popular type of crane-charging depends upon a wishbone-shaped casting that is installed in the cupola at the charging door. The cone-bottom bucket is suspended from the bottom so that the crane only has to place the bucket where its top flange will come to rest upon the wishbone. The craneman then lowers his hook, thus discharging the material and distributing it as desired in the cupola.

Mechanical charging has also been extended to smaller foundries where the equipment is adapted to the tonnages involved. The skip-hoist charger does an excellent job on small cupolas, saves considerable labor, provides much safer and more pleasant working conditions for the charging men, and does away with the need of a charging platform or an elevator. The installation of a charging system of this kind calls for an engineering survey, and in most cases it must be a "tailor-made job" if best results are to be obtained.

The old-time foundryman had a very good idea of the pressure of the blast at the wind box, but his information concerning the volume of air delivered to the cupola was very sketchy. Today, air-weight-control equipment insures the delivery of a constant weight of air per minute regardless of atmospheric pressure or temperature and has served to eliminate one of the greatest sources of trouble and variation in cupola operation. Another and more recent innovation in the foundry is the apparatus used for dehumidifying atmospheric air. Manufacturers of piston rings have found that it is practically impossible to make satisfactory rings without employing equipment to dry the air, and today all foundrymen are showing great interest in air conditioning. Moisture delivered to the cupola calls for additional coke to evaporate it, and it is also necessary, for uniform operation, to keep adjusting the coke ratio in order to compensate for the difference between dry weather and damp weather. Dehumidifying systems eliminate this troublesome variation, and will undoubtedly become more popular, in fact essential, as time goes on. Obviously, every variable eliminated makes for more certain control of cupola operation.



CUPOLA SPARK SUPPRESSOR

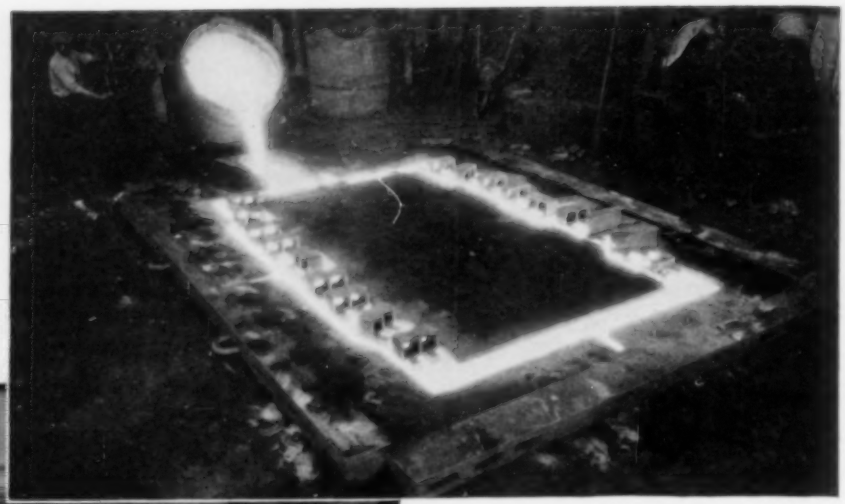
This new type of apparatus uses a water spray to kill flames and to collect smoke, light fly ash, and sparks. It assures a clean roof, eliminates the fire hazard, and is effective during blackouts because it gives no telltale glow, a feature that is of importance in wartime.

The hot blast is of twofold benefit: it effects great economy and brings about uniformity in cupola operation. Some 30 foundries in the United States are now using this equipment. By means of it, the waste gases, which are combustible, are exhausted from the cupola at a point below the charging door and are burned in a separate chamber, whence the products of combustion pass through a heat exchanger and preheat the blast to about 600°F. Coke economy is around 30 per cent, and silicon loss is cut approximately 50 per cent. Furthermore, it is possible to control the temperature and composition of the iron with far greater accuracy by hot-blast than by cold-blast operation. Unfortunately, hot-blast equipment is rather expensive, and its use up to date has been largely confined to foundries that melt large tonnages.

Because the cupola is the most efficient melter of ferrous materials it has been combined with other units that produce malleable iron and steel. The usual combination for malleable iron and high-test cast iron consists of a cupola and an air furnace, thereby largely increasing the capacity of the air furnace and providing a steady supply of metal for continuous molding operations. More than 30 per cent of all the malleable iron produced in this country today is melted in cupolas and refined in air furnaces. The cupola is also finding application in the steel industry through the triplex process, which, in addition to the cupola, involves the use of a side-blow converter and an electric furnace. A large tonnage of steel castings is also made directly from converter metal, which, of course, is melted in a cupola prior to the converter operation.

Large cupolas of recent installation are now melting iron and steel scrap which is desulphurized in a ladle, the desulphurized metal constituting part of the charge for open-hearth furnaces. This practice is of interest to steel plants that have no blast furnaces, inasmuch as the time for the open-hearth heat is thereby considerably reduced and no pig iron is needed in the charge. There are being built some exceedingly large

cupolas that approach blast furnaces in size and design. These will be used to melt briquetted borings and turnings and miscellaneous iron and steel scrap. The cupola metal will be desulphurized; transferred to Bessemer converters for removal of silicon, manganese, and carbon; and finally refined in basic electric furnaces. This system is expected greatly to reduce the power consumption of the electric furnace and materially to decrease the time needed for a heat.



IN A MODERN GRAY-IRON FOUNDRY

Molten metal is running from a 60-inch cupola into one ladle (left) while a large mold is being poured from a second ladle. The other view shows the pouring of a simple casting—a lifting ring for a turboblower.

Operating the Cupola

*D. J. Reese**

BEFORE chemistry and metallurgy entered the gray-iron foundry, the suitability of pig iron for the type of casting to be made was judged by the appearance of the fracture, which might be white, mottled, gray, silvery, black, coarse, fine, etc. Castings also were subjected to fracture examination; and it is from the fracture that gray iron derives its name. Today, even though chemistry and metallurgy are of great aid to the foundryman, fracture tests are still indispensable to him.

With the introduction of chemistry, fracture, or qualitative examinations, were supplemented by quantitative analyses of pig iron and of the gray-iron product. The quantitative test told the foundryman how many pounds of silicon there must be in each ton of gray iron to obtain the proper fracture, how many pounds of silicon would be lost in the cupola melting practice, and how many pounds of silicon must be in the cupola charge.

As gray iron is a ternary alloy of iron, carbon, and silicon, it was found that the foundryman, even though knowledge of the amount of silicon present was definitely helpful to him, needed still more quantitative information to do a perfect job. Hence, emphasis on the more important element in iron chemistry has gradually shifted from silicon to carbon—or, rather, emphasis has been put on both carbon and silicon, with carbon the more important of the two. There are many reasons why this is so, as follows:

The amount of carbon is generally greater than the amount of silicon. Gray iron usually contains from 50 to 80 pounds, or 2.5 to 4 per cent, of carbon per 2,000 pounds of metal. Silicon ranges from 10 to 75 pounds, or from 0.5 to 3.75 per cent. Frequently, when the silicon content is very low (0.5 per cent), the carbon content is very high—more than 3.5 per cent. But even when silicon is very high (3.75 per cent), carbon usually is also high—3.5 per cent or more.

Carbon in gray iron is always present in two forms—as free graphite and as combined carbon. Silicon is dissolved by iron and is present only as silico ferrite. Graphite is always in the form of flakes, which may be extremely short or comparatively long (under a microscope at 100 magnifications), ranging from ⅛ inch to as much as 4 inches. These flakes may be uniformly distributed throughout the sections of a casting, or they may be segregated. When the graphite is segregated, the gray-iron section can be likened to a steel chain which has one weak link.

Graphite has a very low specific gravity, 2.3 as against 7.8 for iron. This means that the specific gravity of gray iron will vary with the amount of graphite present, and it is therefore of importance that its volumetric influence be recognized. When a chemist reports 3 per cent graphite in cast iron, he means that the volume of graphite is about 10 per cent of the structure. In other words, in each 10 cubic inches of metal is 1 cubic inch of graphitic carbon.

By far the largest tonnage of gray

*Steel Division, War Production Board.

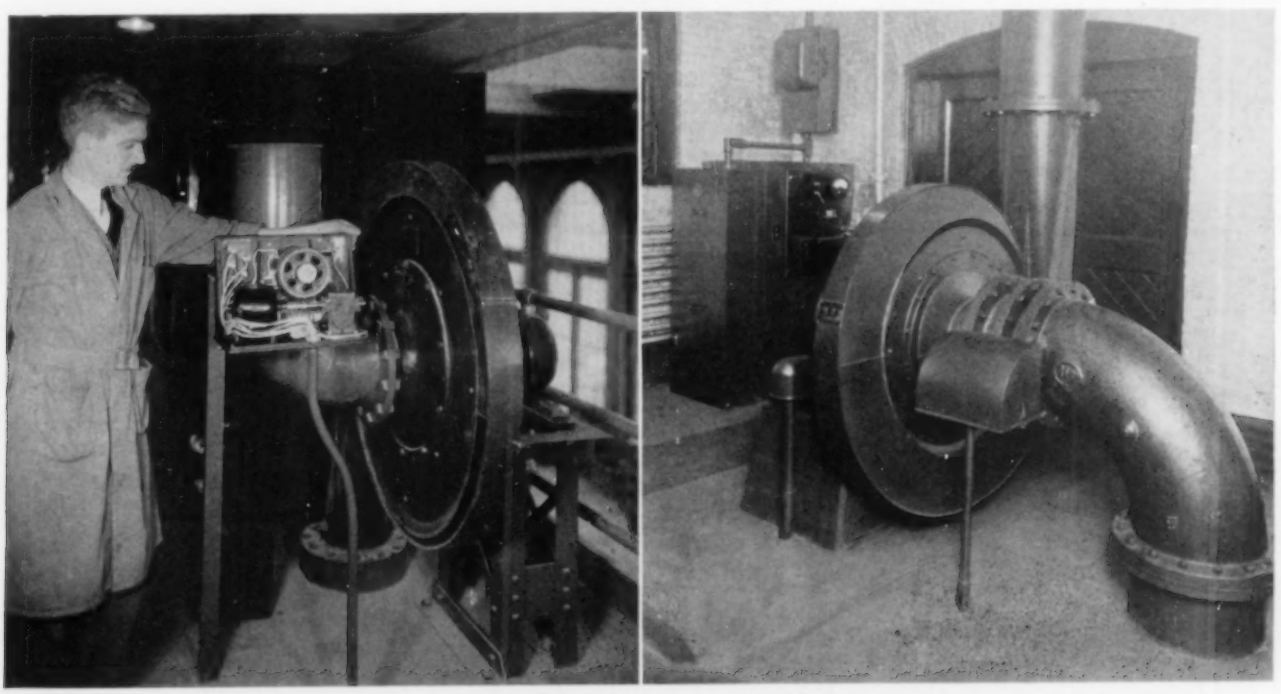
iron is melted in the cupola where carbon, in the form of coke, and metal are in intimate contact all the while they are in the furnace. Consequently, the job of controlling gray-iron carbons requires an intimate knowledge of what takes place in the furnace. A characteristic of the cupola is that it saturates metal with carbon, and it takes skill to operate a cupola so that the gray iron will contain less than the amount of carbon required to saturate it. As mentioned previously, gray iron usually contains 50 to 80 pounds of carbon per 2,000 pounds of metal; but when 2,000 pounds of metal is charged into a cupola it is exposed to some 150 to 600 pounds of carbon, or several times the quantity needed to saturate it. Cupola fuel should therefore be handled so that the maximum percentage of it will participate in efficient thermal reactions and only a minimum amount will be dissolved by the iron.

Foundry cokes of metallurgical quality are obtained by selecting the most suitable coals, coking cycles, and sizing and are made for the maximum generation of carbon dioxide—in other words, maximum heat per pound of carbon. This means that the coke industry is cognizant of the need for metallurgical-quality fuel; and if its importance in the cupola melting process is recognized, then considerable gain can be made not only in cupola operations but also in the quality of its product. Moreover, it will be possible to furnish the coke industry with the data required to improve the metallurgical quality of foundry coke.

No foundryman handles cupola fuel intelligently unless he sees to it that each fuel charge is weighed, and weighed accurately. It is poor economy to think of fuel consumption in cupola-melting in terms of possible fuel savings, as the cost of coke is a minor item. When the problem is approached from the proper angle—that of the effect of the fuel on the quality of the gray iron, then it is being viewed in the proper perspective, and the resultant over-all economy is far greater than any fuel savings that might be effected.

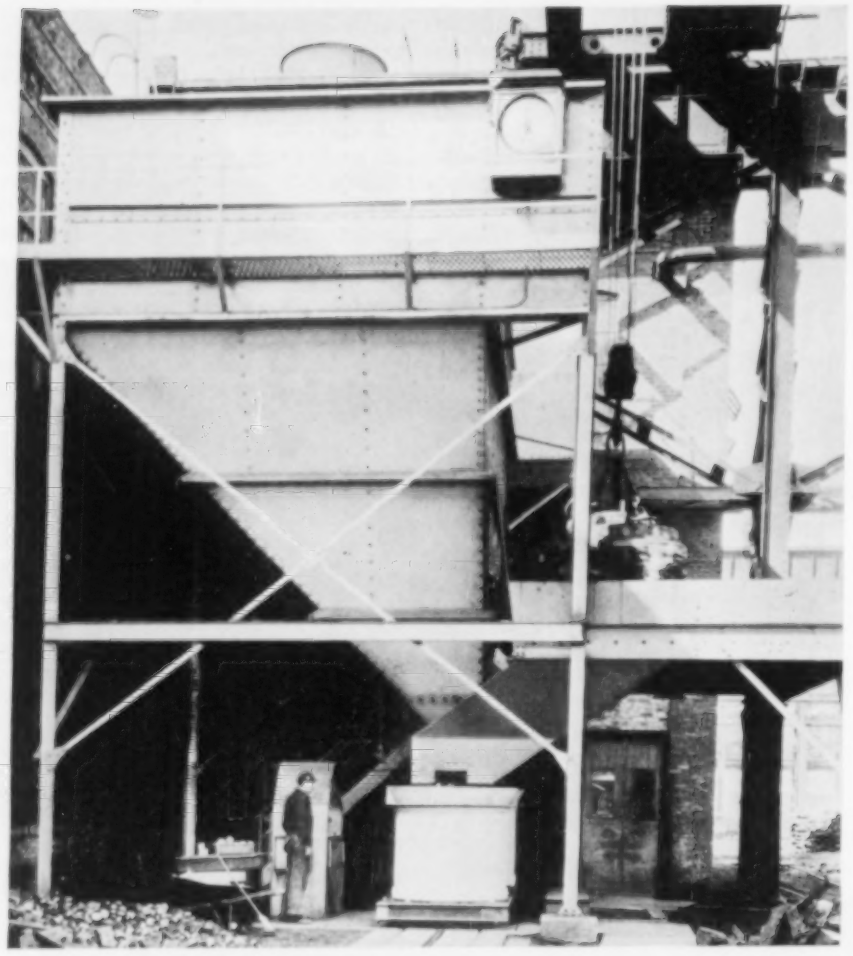
Let us say, for example, that the minimum amount of coke required to melt iron in a cupola to a temperature of 2,850°F. is approximately 140 pounds per 2,000 pounds of metal. All the fuel must take part in efficient thermal reactions; none must be dissolved in the iron. If the metal dissolves carbon, then a correction must be made in the coke charge. A foundry coke may or may not be properly sized for the particular cupola being used. For instance, 12-ounce particles would be suitable for a 42-inch-diameter cupola, while 7½-pound particles would not be of the right size. A cupola capable of melting 20 tons of iron an hour cannot be expected to do an efficient job if it is being used to melt 10 tons or less. A temperature of 2,850°F. at the tap spout depends upon the melting point of the materials in the charge and the amount of superheat added to the metal after it is melted. The melting point of a low-phosphorus iron is higher than that of a higher-phosphorus iron; hence, if a foundryman wants 2,850°F. with a 0.05 per cent phos iron, his problem will differ slightly from that of a foundryman producing 0.75 per cent phos iron. However, both types of iron could be tapped at 2,850°F. with the same fuel ratio if the operating details were adjusted to meet the job requirements.

The proper fuel charge of any cupola can be established on the basis of 7.5 pounds of coke per square foot of cupola area. For example, a cupola having an inside diameter of 48 inches (an area of 12.57 square feet) would need nearly 95 pounds of coke for the intermediate coke charges. The weight of the iron charge depends on the weight of the coke charge, giving proper consideration to the amount of fuel that will be dissolved



CONSTANT AIR-WEIGHT CONTROL

Without proper air control, every cupola will at times receive too much or too little air. Extra coke is required to heat a surplus of air, which will also increase oxidation of the iron unless more coke is added. Insufficient air causes slow melting and cold iron, and consequently increases the number of defective castings. By providing its Motorblower with constant air-weight control, Ingersoll-Rand Company has improved the iron-to-coke ratio in foundries from as low as 6 to 1 to an average of 10 to 1 and, in several cases, 12 to 1. This control is effected electrically, without the loss of air, by automatically operating a blast-gate valve to maintain the desired flow of air for most efficient cupola operation. The picture at the left shows a small blower used in the foundry of the Brooklyn Technical High School, with its blast-gate control mechanism exposed to view. The other picture is of a 50-hp., 6,000-cfm. blower installed in a commercial foundry. The housing for the blast-gate mechanism is visible in the center. The control panel for the blower is in the background.



EFFICIENT MATERIALS HANDLING

All materials are unloaded by overhead crane, using an electromagnet and grab bucket. Coke is stored in the large hopper at the left and fed by gravity into a charging bucket at ground level. Limestone is similarly handled. The iron materials are picked up by a magnet and dropped through the chute of the loading platform at the right into a charging bucket below. All weights are accurately recorded on the dial scale that is at the top of the coke hopper and in full view of the crane operator.

in the melting process by the iron. This is the reverse of the usual foundry procedure by which an empirical metal charge of 1,000, 2,000, or 3,000 pounds is selected and an arbitrary fuel ratio of 8.5 to 1 establishes the fuel charge at approximately 120, 240, or 360 pounds, respectively.

One might ask, "What is the proper metal charge for a 48-inch cupola using a 95-pound coke charge when the carbon content of the metal charge is as much as the carbon content of the cupola product and when hot iron of 2,850°F. is desired at the tap spout?" As has already been said, only 140 pounds of coke per 2,000 pounds of metal might be needed. This would be a ratio of 14.3 pounds of iron to 1 pound of coke, or 1,360 pounds of metal for a 95-pound coke charge. Now, if a 48-inch cupola is not using these charges, it would not be wise to change to them from regular practice in one drastic step. The desirable procedure would be to maintain the existing ratio between fuel and metal charges by scaling the weight of the coke charge down to 95 pounds and gradually increasing the weight of the metal charge in small steps —say from 750 to 800, to 850, to 900 pounds, etc.—over a period of weeks or months until it weighs 1,350 or 1,400 pounds.

Most cupola metal charges contain some steel or have a carbon content less than the amount present in the cupola product. For example, if it is desired to produce a 2.5 per cent carbon iron with a charge containing possibly 60 per cent steel, the cupola charge would contain 1.35 per cent carbon (or less if the cupola practice is not of a high order) and the amount of carbon to be absorbed from the fuel would be 1.15 per cent or more. What metal charge should be used in the case of a 48-inch cupola and fixed intermediate coke charges of 95 pounds? A carbon increase of 1.15 per cent would mean 23 pounds of carbon per 2,000 pounds of metal; but inasmuch as coke is about 90 per cent carbon, the 23 pounds of carbon would be equivalent to 26 pounds of coke. Instead of melting the 60 per cent steel charge with 140 pounds of coke per 2,000 pounds of metal, 26 pounds more would be needed, or 166 pounds of coke. The maximum fuel ratio would be 12 to 1 instead of 14.3 to 1, as in the first case. With a 95-pound coke charge, the metal charge could be 1,140 pounds. Here again the alert foundryman would keep his present relationship between fuel and metal —while scaling down the coke charge to 95 pounds (for a 48-inch cupola) he would gradually increase the metal charge from 750 to 800, to 850 pounds, etc., over a period of time involving weeks or months, until it reached 1,140 pounds.

What is wrong when a foundryman wishes to produce a 2.5 per cent total-carbon iron and he uses more and more steel in the cupola charge (lowering and lowering the carbon in the charge) until the ingoing carbon is 0.5 per cent or less but the cupola product will contain 3.2 per cent carbon or more? In this case the carbon increase is 2.7 per cent—that is, 54 pounds of carbon or 60 pounds of coke per 2,000 pounds of metal. Instead of 140 pounds of coke he would be using at least 200 pounds—possibly a great deal more, because the fuel taking part in the thermal reactions is probably producing a minimum of carbon dioxide and a maximum of carbon monoxide. This foundryman would not be using 95-pound coke charges; he would most likely be using 200 or 300-pound coke charges.

The amount of coke to be used in the coke bed depends upon the cupola operation and is not determined by weight but by measurement—inches of coke above the top of the main row of tuyeres. If there is a pressure gauge on the wind box, the proper height of the bed can be established by a simple formula. The height should be 10.5 times the square root of the wind-box pressure (ounces) plus 3. Mathematically it would be expressed as

$$BH = 10.5\sqrt{P} + 3$$

If the wind-box pressure is 4, 9, 16, 25, or 49 ounces, the bed height should be 24, 34.5, 45, 55.5 or 76.5 inches, respectively.

Foundry operations with close to 16 ounces of wind-box pressure are not infrequent and call for a bed height of 45 inches. If a low total-carbon iron is to be produced in a cupola, the height of the bed must be established with accuracy. There are other ways of determining the correct bed height, but lack of space does not permit mentioning them here. It should be remembered that the measurement is established after the coke bed has been burned through to a white heat and that no cold coke should be added.

It has been stated that the fuel charge should be accurately weighed and that the amount should be in proportion (7.5

pounds per square foot) to the size of the cupola. However, it should also be properly sized. Foundry metallurgical cokes might weigh 4, 8, 12, 16, or 24 ounces per particle. A 24-ounce (1½-pound) particle is a large one for any cupola. Particles of 8, 12, or 16 ounces would be ideally sized for 30-, 42-, or 54-inch-diameter cupolas, respectively. Very small cupolas might well use 4-ounce particles. Not all suppliers are equipped to provide sized coke, nor can they always furnish a size small enough to meet the needs of the cupola in use. In such cases it is best to let either the size of the cupola most frequently used or the smallest of the cupolas in service determine what size of coke to buy.

If a foundryman using a 48-inch-diameter cupola were asked how much iron he melts and how much air he uses he would probably reply, "Nine tons of iron per hour and about 4,000 cubic feet of air per minute." Both parts of the answer include units of weight and time. But as the cupola is a high-speed melting unit, and a time interval of one hour is too great to permit a student to master its complexities, he might better have said 300 pounds of iron per minute or 5 pounds per second. Air has weight. At sea level and at a temperature of 60°F. a volume of 13 cubic feet weighs 1 pound. Thus, instead of 4,000 cfm., it would have been preferable to say 300 pounds of air per minute.

It is helpful in studying the cupola to reduce all units of weight or time to pounds and minutes. You will note that our cupola melts 300 pounds per minute and uses 300 pounds of air. But this ratio of 1 to 1 does not apply to every cupola. One that has a high thermal efficiency will melt more than 1 pound of iron for each pound of air used; and, conversely, another with a poor thermal efficiency will melt less than 1 pound of iron for each pound of air used. Once a foundryman establishes this ratio between cupola melting rate and air flow he can, from day to day, vary the metal flow to pouring floors by varying the air flow. This method would not be a useful one for varying the quantity of metal from one hour to the next in any one day, but it would be helpful in a foundry that is geared to continuous mold conveyors where the tonnage molded per minute changes with business cycles and with types of patterns. The 1-to-1 ratio would also be of aid to the foundryman interested in establishing a superior cupola practice. It would help him to improve the thermal efficiency of his cupola; to understand what changes occur in cupola operation when the slag hole burns out and a large quantity of air is lost through it almost as soon as the air enters the cupola at the tuyeres; to appraise the effects of air losses between the blower and the cupola; and to catch radical changes in operation, such as mistakes in using too much coke, etc.

Air has always interested foundrymen, for otherwise they would not have designed fancy blast-pipe arrangements, experimented with multiple rows of tuyeres, or installed tuyeres of their own design. The chemist says that air is colorless and odorless; the foundryman says that it is not only colorless and odorless but also mysterious. However, air is not mysterious to air-conditioning or aeronautical engineers, nor to designers of cupola blowers, and it will cease to be so to the foundryman once he begins to use it as a commodity, just as they do.

In recent years foundrymen have installed several types of air-measuring and air-weighing devices to get better cupola performance. In addition, increased interest has been shown in preheating and in air-conditioning equipment. The usual preheater supplies a cupola with air at 500 rather than 60°F. (or atmospheric temperature). But such a unit is rather expensive and is usually not practical unless a cupola is operated for at least 6 hours, preferably 8 hours. However, not until all other good practices have been introduced should a foundryman consider the installation of preheating equipment. Preheating the air permits higher combustion temperatures in the cupola so that higher metal temperatures can be obtained; and because the reaction between preheated air and coke takes place well-nigh immediately, the oxidizing conditions in the cupola are less severe. The tuyere zone is a drastic cooling zone where the slag impurities are apt to become very viscous; but with preheated air the cool-

CHARGING EQUIPMENT

Mechanical charging of cupolas has increased rapidly in recent years and is the means of releasing considerable labor for other work. Below is shown a Whiting underslung type of wishbone charging crane that can serve three furnaces. The other picture illustrates a skip-hoist charger. Because the building was not originally designed for foundry use, the cupola was erected in the yard.

ing effect is less drastic and there is less chance of the cupola being bridged over.

In winter, the water content of the air may be less than 40 grains per pound (3 grains per cubic foot), whereas on a hot, humid summer day it may amount to 130 grains per pound (10 grains per cubic foot). There are 7,000 grains of water in a pound; and if 2,000 pounds of air is used to melt 2,000 pounds of metal, each ton of metal is exposed to about 10 or 12 pounds of water on a dry, cold day or to 35 to 40 pounds on a humid, hot day. Air conditioning, as it is used in the foundry today, serves to keep the moisture content constant the year around—at about 40 grains per pound of air. Air conditioning removes one variable from the metallurgical operation, and this is sufficient reason to warrant its installation. Most piston-ring foundries have had such equipment in use for some years, knowing that it is invaluable for their type of product.

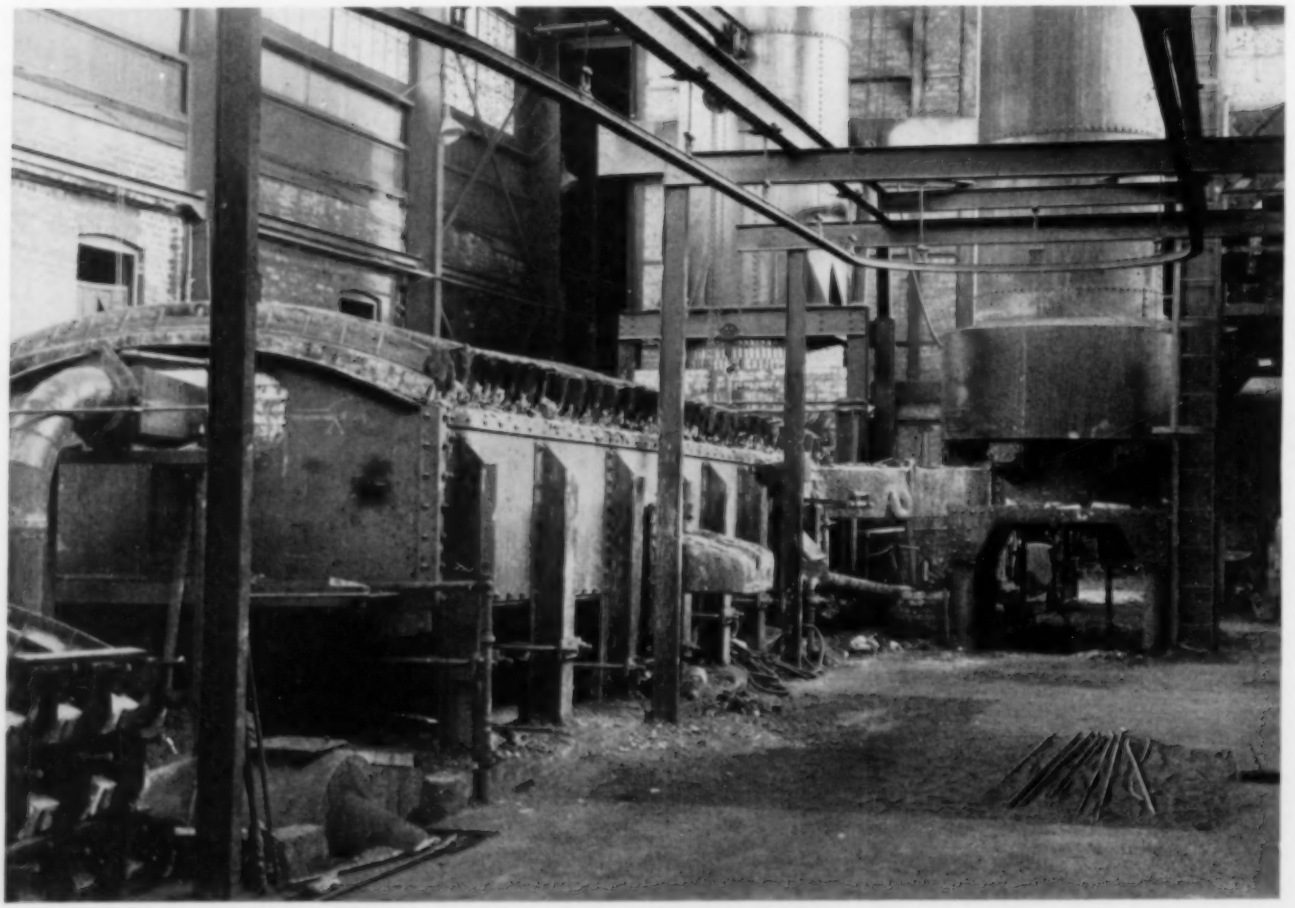
As the moisture content of the air increases, the metal temperature decreases. It is not an uncommon practice in the more efficient foundries to use more fuel or less metal in the charge as the moisture content rises, or to modify the type of charge by decreasing the steel content in proportion to the increase in moisture content. It is probable that moisture in the cupola air is dissociated into hydrogen and oxygen and that the effect of hydrogen in iron is to stabilize carbides, creating unmachinable hard spots. An automotive foundry using up to 25 pounds of coke per ton of iron in addition to the normal fuel charge would have to determine whether this method of compensating for moisture is as positive and economical as is air conditioning. The foundry that alters the components of the metal charge also has to weigh its method of achieving results against air conditioning. It is very likely that more and more foundries will in future give serious consideration to conditioning the air supply.

We are at present living in a period when all our raw materials are going to war and when it is almost impossible to purchase new equipment, particularly equipment that has so far not been used in certain industries. This is true also of the foundry. This may not be as harmful to its best interests as one may have been led to believe, for if one accepts the premise that past cupola practices are susceptible of much improvement one will find that it can generally be accomplished by applying American ingenuity.

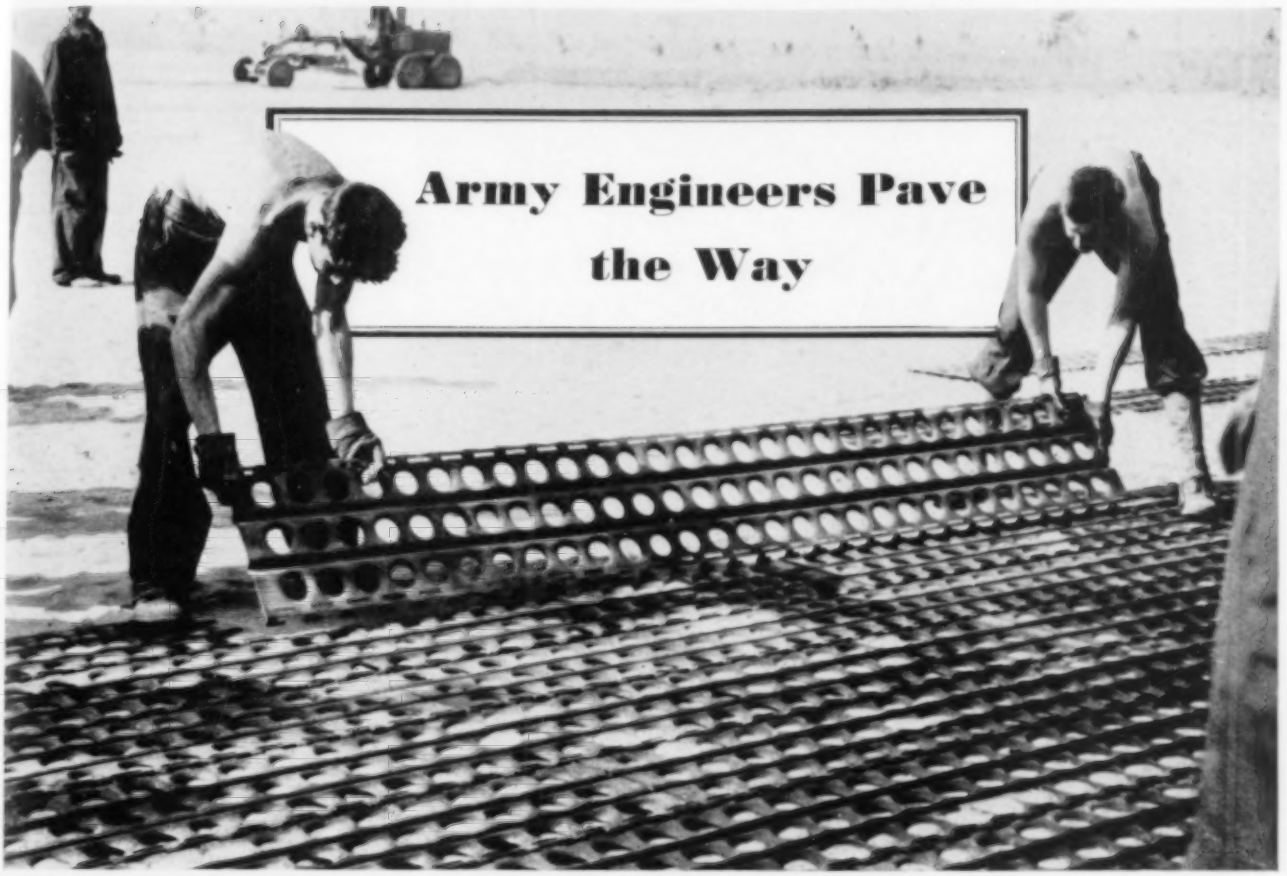
The foundryman has always wondered whether he could do as good a job with mechanical charging as he does with hand charging. This is not an easy question to answer. With some types of equipment very satisfactory charging is possible, while others are deficient. Large tonnages of metal, coke, and limestone have to be handled, and the way they are placed in the cupola has a bearing on cupola performance. When the materials are in motion as they are passed through the charging door by a device that does not enter the cupola, charging is apt to be deficient. Sliding them into the cupola from raised industrial cars is another example of deficient mechanical charging. Skip hoists and similar charging equipment also may prove to be unsatisfactory. Systems involving the use of charging buckets which are dumped only after they have been properly positioned inside the cupola are very likely to be suitable. However, even they are not fool proof. Charges are put into the buckets in a number of ways, some of which approximate sliding (like skip-hoist charges), and these do not contribute to satisfactory cupola charging conditions.

FURNACE COMBINATION

A cupola (right) and an air furnace (left) are arranged in series for making malleable iron. Such a combination increases the capacity of the air furnace and provides a steady supply of metal for continuous molding operations. About one-third of the country's malleable iron output is produced in such duplex installations.



Army Engineers Pave the Way



KNITTING AN AIRFIELD RUNWAY

Perforated steel strips, each 16 inches wide and 10 feet long, are linked together to form a continuous runway capable of supporting the largest and fastest planes. When the one shown in this picture was finished, it was 150 feet wide and 3,000 feet long. Nature furnishes the camouflage, as grass grows through the holes.

THE brilliant victory of America's Second Army Corps in Tunisia has drawn attention to the amazing achievements of the U.S. Army Engineers in building roads at the north African front. Through the mud and dust, they have laid down roadways at a rate as high as 4 miles an hour. That is quick time for marching on roads, much less building them; but even greater construction speeds are in prospect.

A newly created pioneer road-team organization is making these record performances possible. In Africa, tractor-bulldozers were carried ahead on 6-wheeled-drive desert trucks to attack critical points such as steep-banked washouts, gullies, or bomb and shell craters. These were followed by "V" drags, pulled either by tractors or tanks at as much as 12 miles an hour, that cleared the roadways of debris. A high-speed motorized grader finished the job of grading and scraping. Reports from the front have given some isolated hints of the importance of these operations. A dispatch from Tunisia, for instance, commenting on the failure of German demolition work to slow up the American main columns, stated: "The damage done here would certainly have held up our main columns a full day and night if we had not had full roadmaking equipment handy and sufficient pioneer battalions to undertake the gigantic task."

Referring to the dramatic shift of General Patton's Second American Corps to the north, the chief of the general staff of General Alexander's 18th Army group, said: "The movement of such large bodies of troops directly across the Allied lines of communication was an extremely difficult maneuver, but was carried out with great secrecy and without confusion. It involved the movement of troops, great quantities of stores and equipment along the whole length of the front, and senior British officers have the fullest admiration for the excellent staff work, particularly for the speed and secrecy with which the move was carried out. The roads were kept open by incessant work of the Engineers, equipped with some of the most modern mechanical road-making equipment in the world." This is a picture of North Africa, with U.S. Army Engineers in action.

On the other side of the world, the exploits of the Army Engineers also are significant. In regard to the military construction work carried out in Australia during the past year, Brig. Gen. Hugh Casey, General MacArthur's own engineer from Brooklyn, N.Y., had this to say in an International News Service dispatch from United Nations headquarters in Australia: "One year ago such a strategic and vital possession as New Guinea had but one airdrome, no more than 23 miles of hard-surfaced roads, no adequate wharf facilities, water supply, storage areas, hangars, or repair shops. Today, more than 100 airdromes in Australia and New Guinea have been built or made serviceable by U.S. Engineers working in close coöperation with Australian military and civilian construction men. Nearly 15,000 miles of Australian roads have been built or improved."

Hospital accommodations for tens of thousands of troops have been provided in New Guinea and Australia. Wharfage facilities have been improved in every key Australian harbor, and berthing facilities have been increased nearly 500 per cent. Great repair depots and service fields have been completed for the fast and heavy bombers which are winging their way from United States factories to the Australian theater; vast

USE OF AIR TOOLS

Portable compressors and air-operated tools accompany U.S. Army Engineer battalions wherever they go. The outstanding Army construction job in this war was the building of the Alcan Highway (left). The Engineers are called upon to demolish structures as well as build them, and the trainee shown below is drilling a hole in a concrete abutment preparatory to shattering it with dynamite.

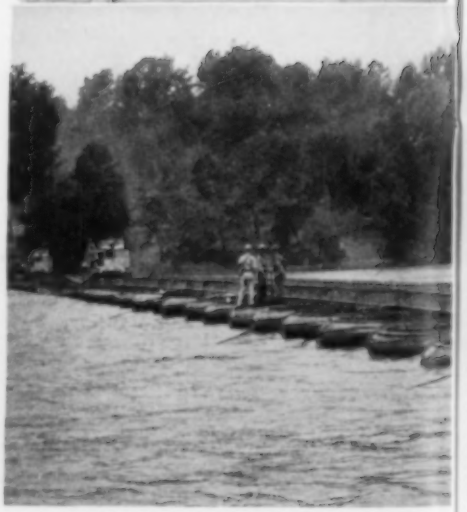
storage depots have been constructed for the matériel vital to the war effort in the southwest Pacific; and provision has been made for adequate water supplies in the combat sectors.

Thus, while a Schickelgruber, a Mussolini, and a Tojo have been talking of world conquest, this year of 1943 is witnessing the spread of American arms from North Africa to New Guinea, and the United States may become the first nation in history to put men and equipment on battle fronts, active and potential, in every part of the world. From the Aleutians to Australia, from Britain to Buna, from India to Iceland, there is today no major field of operations in which one cannot find either American men or equipment fighting or being made ready to fight.

The part which the Corps of Engineers plays in this world-staggering achievement is a tribute to American organizing and construction skill. The people of the United States not only have entrusted the housing, care, and protection of American troops to that body but they have also given it supervision over the greatest emergency building program, covering all types of military installations, the world has ever seen. In a time span that can be measured in months, Army Engineers have had charge of the construction in every part of the globe of more than $10,000,000,000 worth of military facilities, an amount that represents the total cost of the Panama Canal twenty times over!

Yet, the position of the Army Engineer is a peculiar one; he cannot disclose anything about most of his work for reasons of military security. One sentence will make it clear why it is of the utmost importance that the information be guarded, namely, "What the engineers are doing now is an accurate index of what the Army intends to do in the future." If they told you in detail what they are doing today, they would be announcing the plans for the United Nations offensives in 1943 and 1944, for the Engineers pave the way.

At present, it is permissible to speak only in the most general terms. It can be told, for instance, that there is a major change in emphasis on the work of the Corps—a change from building training camps, ordnance factories, and bases at home to the construction of springboards for offensive actions in the war zones themselves. It has been more than two years now since ground was broken on the Atlantic bases leased from Great Britain, and not quite two years since work was started on the North Atlantic supply route to Great Britain via Greenland, Iceland, and northern Ireland. In that time routes have been developed that, in spite of submarine warfare, are assuring us that American strength will be felt on the battle fronts. The long overwater jumps have been girdled with strings of airfields to the South Pacific, across the Atlantic to Africa and the Middle East, and north over the top of the world to fighting Russia. The Army Engineers have built the Alcan Highway, punching tractors north through country not even the Indians and the Eskimos knew too much about, pushing timber down, bridging



muskeg bogs, burning a trail through to Alaska in one furious summer.

Like waves reaching out from a stone falling into still water, American power has encircled the globe with the Engineers. In carrying out their construction program, they have so far depended primarily upon civilians—civilian contractors and civilian workers. As the manpower shortage has grown more and more critical, women have been moved in and are even doing work that was ordinarily considered beyond their capacities. It can be said truthfully that no branch of the service has been more keenly alive to the need of making the wisest possible use of America's pool of skills.

The Corps is now at a critical point. To continue paving the way for American offensives overseas, it must have an army of construction men in uniform. Specifically, it needs to recruit a total of 9,000 men skilled in 75 specialities. This is no ordinary recruiting program. To begin with, the status of any construction project in the United States whose completion is vital to the war effort must not be jeopardized thereby. The aim is to enroll only those workmen who are wondering what to do next and to guarantee them a continuance of their trade in uniform. Men released from work as the building program tapers off will be given every assurance that their job classification and past experience will be protected when they join the growing American Army.

Contrary to most recruiting drives, nothing more is promised than that there is room on a pretty swell team for some rugged downfield blockers and that men with skills will be put to work immediately at those skills. The men are going to be handpicked, and each of the prospective volunteers under this new program will be interviewed by an Army Engineer. If, at such an interview, it is decided that the man has the stuff needed, he will be given a letter to his induction station which will automatically earmark him for assignment to the Corps of Engineers.

The foregoing is the substance of an address on *The Function of the Army Engineer in the Theater of Operation* made by Lieut. Col. E.W. Garnisch before the Syracuse Builders Exchange. In summing up, Lieutenant Colonel Garnisch said:

"We are promising nothing more than that we will teach a man who already knows his tools how to fight with those tools. The training we will give him at our Engineer training centers will pull no punches. He will go through a course that will prepare him for doing the job we need done. He will come out of our training course just as good a soldier as he is a worker. He will be ready for combat.

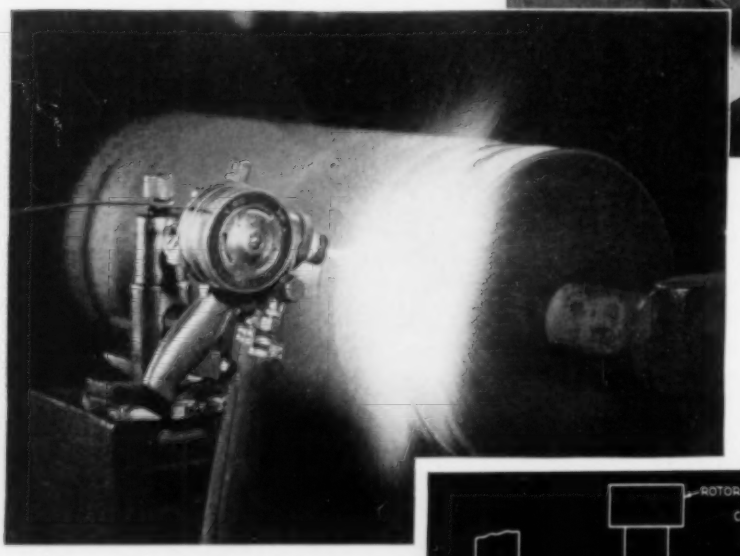
"From the results we have secured thus far to our challenge, we will not need to make any other offers. America's skilled workmen have been waiting for just this chance to use their skills in uniform. We are evidently getting the cream of the crop. The records of the 497th Engineer Maintenance Company show the type of soldiers we are getting. This company was drawn entirely from former employees of a large American industrial concern, men ranging in age up to 51, volunteering as buck privates when they found that their skills were needed in uniform. When the 497th went on the rifle range to fire for record, 91.3 per cent of the men qualified as rifle marksmen. That is a record to shoot at.

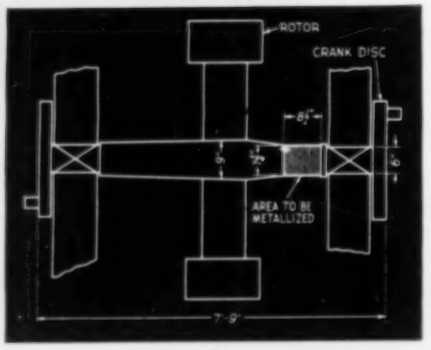
"On June 16 we celebrated the 168th anniversary of the naming of the first Chief of Engineers. From the time George Washington first saw the need of professional advice in planning field fortifications, the Corps of Engineers has constituted the professional heart of America's citizen army. Members of the Corps who serve in peacetime capacities as builders of the nation's waterways, harbors, and flood control works have been trained to administer vast undertakings. Their achievements are built solidly in the economy of a peacetime America. Now, with their work intensified by the crisis of war, their horizon has expanded to the uttermost reaches of the world."

MARINE ACTIVITIES

Providing means for fording streams and other waterways is an important function of the engineering troops in combat areas. At the left, General Grant tanks are crossing a steel highway laid on rubber pontons. The view above shows engineers ferrying a 37-mm. gun and a ¼-ton truck aboard an inflated rubber boat. Outboard motors furnish the power.

Worn Compressor Shaft Metallized in Place





METALLIZING OPERATION

Because of the restricted working area, the spraying was done by hand (above) and the rotor and stator were protected by asbestos sheeting. The picture at the left illustrates the type of gun that was used, but in this case it is mounted and set to do the work mechanically. Below is a plan view of the shaft showing the worn section.

IN THE department of maintenance and repair in humming industrial establishments, the art of metallizing holds an important place today. New machines or parts are difficult and sometimes impossible to obtain, and it is therefore incumbent upon managements to do everything that will keep available equipment in running condition. This is good practice not only in war but also in peacetime, and the chances are that the lessons we are learning now will in future prevent a repetition of the waste we as a nation indulged in in the days when we did not have to husband our resources.

How extravagant we were in this respect is exemplified by the following incident witnessed about fifteen years ago by passengers on a ship bound from San Francisco, Calif., to Seattle, Wash. True, it is an unusual case, but it emphasizes our point. To quote from a report of the Office of War Information of the WPB: "A crane dropped its hook into the hold and brought forth one of the vessel's auxiliary Diesel engines. The machine was lifted clear of the deck, swung out over the side—then dropped into a watery grave. Next, the crane picked up from the deck a brand new engine of the same type as the one consigned to Davy Jones' locker and lowered it into the depths of the ship. Carried out with some degree of ceremony, the operation made a deep impression on one of the passengers. He was shocked to see several tons of valuable metal abandoned where it could never be salvaged for continued usefulness in some renewed or reincarnated form. But this was the affluent twenties when no one thought about any shortages of steel, copper, aluminum, and other metals."

Such a procedure would be unthinkable today, when every bit of scrap is conserved for vital war production and machinery or equipment doing useful work must be kept going despite increased wear and tear resulting from continuous operation. Unless irreparably worn, no part is discarded for a new one if it can be put back in shape by one of the several metal-surfacing methods such as electroplating, welding, and metallizing now extensively practiced. Furthermore, it can be made serviceable with a minimum of delay and prevent a raid on the precious stock of spare parts.

The art of metallizing, with which we are at present concerned, originated abroad about 30 years ago but found comparatively little use in this country until 1933 when improvements in the process greatly widened its field of application. The metals used include aluminum, babbitts, copper, brass, bronzes, lead, cadmium, nickel, carbon and stainless steels, tin, and zinc. They come in powder or wire form and are automatically fed into a "gun" where the metal is fused under high temperature, atomized, and sprayed with compressed air on to the part to be built up. But before application, the surface is made rough to assure a perfect bond between the old and the new metals.

Many large manufacturing plants, machine shops, railroads, and shipyards —to list only a few—have their own metallizing equipment, which is of the portable type so that it can be moved about as needed. Or the work is performed by concerns that specialize in it —the latter doing it either in their own shops or, in the case of bulky machinery where the part can be repaired in place, right on the spot. An unusual job of this kind was recently done by the Dravo Corporation at the west shipyard of its Neville Island plant. The part involved was the 1,300-pound crankshaft of a compressor that supplied 1,730 cfm. of

air for use in the shops and yard. The shaft is 7¾ feet long, varies in diameter from 9 to 6 inches, and is made of 40-carbon steel. It carries the rotor for the synchronous motor, as well as the flywheel which drives the belt for the exciting current generator. The damaged section was 8½ inches long and 7¾ inches in diameter and was at the point where the flywheel clamps on to the shaft. The wheel is in two halves, one of which is provided with a keyway for the 1x1x7½-inch key. They are bolted together and should grip the shaft tightly.

Under normal conditions, the life of such a shaft is as long as the compressor. But in the case of the machine in question, the flywheel had somehow worked loose and started to wear away the shaft at that point until it was approximately 0.025 inch undersize, tapered, and out of round. The bore of the wheel also was worn out of round about 0.015 inch. In an attempt to repair the damage, shim stock was wrapped around the shaft and the flywheel hub was drawn down on it. This was done twice, using 0.015-inch and 0.02-inch stock, respectively. Each time the compressor was shut down for about 8 hours, and three men spent as many hours apiece on the job, but the flywheel remained tight only for less than 24 hours.

Consideration was next given to removing the crankshaft and pressing off the rotor for the purpose of turning down the worn section of the shaft to a true diameter, boring out the flywheel, and inserting a thin sleeve or bushing to bring about a tight fit. Among other things, this would have necessitated tearing out the side of the compressor building and obtaining the services of a crane to transport the shaft and rotor to the machine shop. The idea was therefore abandoned in favor of metallizing the shaft in place. To do this, a controllable method of rotating the shaft had to be devised, as follows:

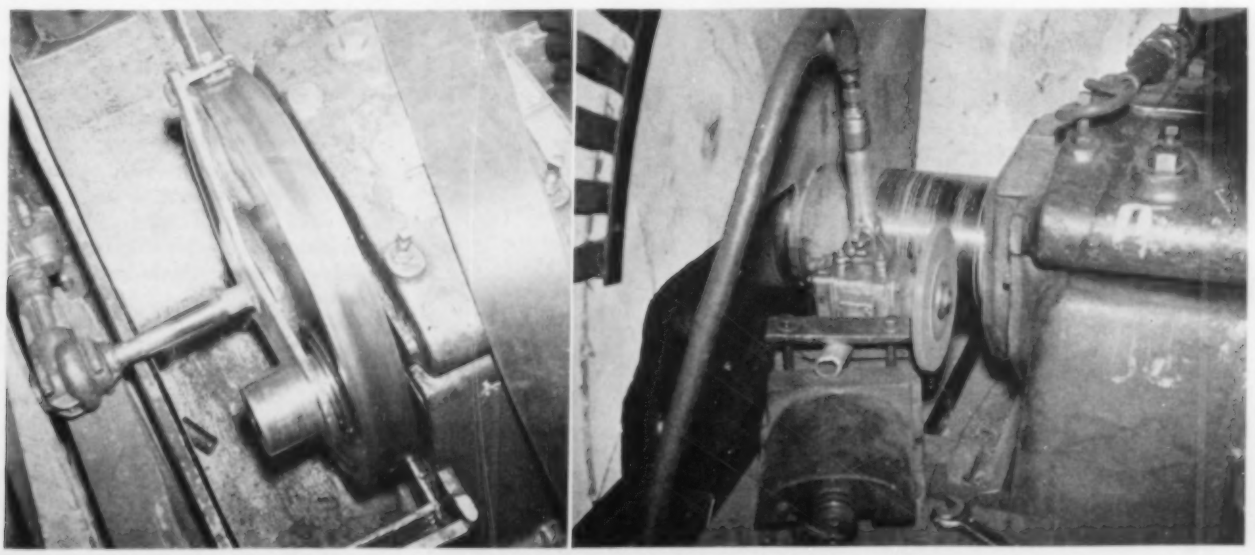
The connecting rods were disconnected at the crankpins, and a yoke, made from ½-inch steel plate, was slipped over one of the pins and hooked at two places over the rim of the crank disk. At these two points, which were approximately 120° in either direction from the crankpin, the yoke was tightened by set screws. After finding the center of rotation of the plate by turning over the crankshaft, a No. 4 Morse taper shank was welded onto the plate so that it was parallel and concentric with the crankshaft. Then, by the use of an air motor with a globe valve to regulate the air supply from the plant air line, it was possible to rotate the crankshaft at any speed up to 120 rpm. Angles and plates were bolted to the base of the compressor to form a foundation for a discarded planer head which was mounted parallel to the crankshaft. On this the cross feed from a lathe was fixed in such a way that the tool post could be moved in a direction perpendicular to the shaft.

As the area to be metallized was restricted on the one side by the rotor and by the main-bearing housing on the other, the only grinder that would do the job was an angle-head air grinder with a ½x10-inch wheel. By rotating the shaft, and with the grinder in the tool post, the shaft was ground true, bringing it down to a diameter of 7.735 inches. Next, with the aid of a standard metallizing, round-nosed threading tool, the shaft was grooved sixteen to the inch by shifting the tool post 1/16 inch at a time with the planer feed and then feeding the tool into the shaft with the lathe cross feed. After the shaft had been grooved the width of the flywheel, the surface was made ready with a Metco shaft-preparing tool. A dummy key was made from bakelite to fill and to project above the keyway 1/32 inch.

Using a Metco 2E gun and 11-gauge 10-carbon-steel wire, the crankshaft was built up 1/32 inch to permit machining it to 7.875 inches. As it would have been awkward to mount the gun in the tool post, spraying was done by hand. After application of the metal, the shaft was ground true by means of the air grinder fitted with a 30-grit wheel, and was then finished with a file. This was necessary to assure the same diameter throughout, inasmuch as difficulty had been experienced in setting up the cross feed of the lathe exactly parallel to the shaft. As it was, only 0.004 inch had to be removed by the file. The job was completed by reinstalling the flywheel, bored out to 7.872 inches.

The work called for the use of 10 pounds of wire, as compared with the 1,300 pounds of steel that would have been required if the shaft had been discarded for a new one. It is estimated that such replacement would have involved an expenditure of from $1,500 to $2,000, and delivery of the shaft would have taken from three to four weeks with an AA-1 priority. On the other hand, by building up the worn area by metallizing, the compressor was put back in service condition in 94 man-hours at a total cost of $316.45.

The text on the metallizing job is based on an article entered by Hugh N. Pendleton, Jr., repair-shop superintendent of Dravo Corporation, in the Conservation Contests conducted by Metallizing Engineering Company, Inc. It won for him a $50 war bond.



PNEUMATIC EQUIPMENT USED

The picture at the left shows the air-motor drive and yoke by which the 1,300-pound crankshaft was rotated to turn down the 8½-inch-long worn section and to build it up 1/32-inch by metallizing. Compressed air for the motor was taken from the shop air line and regulated by means of a globe valve. The grinder used (right) was of the angle-head type and was air operated. All the work was done with the shaft in place.

The Wind That Talks

Charles Huff

DEVELOPED originally for the purpose of welding more closely the far-flung reaches of the 16,000,000-acre Navajo Reservation of northwestern New Mexico and eastern Arizona, the short-wave radio network of that reservation is today playing an essential part in the national emergency. Termed "The Wind that Talks" by superstitious John Navajo, this network was inaugurated some six years ago as a means of providing the "spoken word" in promoting the rehabilitation work of the Indian Service throughout the homeland of the Navajo.

Since there is as yet no generally used written language among the 50,000 members of the tribe, Government-sponsored programs to be successful must rely almost entirely on word-of-mouth explanations. In fact, Navajo Service aides have formed classes for instruction in the Navajo tongue—rather than *vice versa*. However, where once the radio programs were designed to teach tribal members methods of farm and range improvement, the network today carries requests for laborers needed for both on and off-reservation defense work. As an example of their fitness, several hundred are now employed in unskilled and semiskilled positions at the Wingate Army Ordnance Depot near Gallup, N. Mex.

With a limited operating personnel, many of the original planners being in the Army, the principal station is located at Window Rock, Ariz. This station is of 250-watt power—one of four sending-receiving centers used earlier in the network. Window Rock—known to the Navajos as *Nee alneeng*, which means world center—is a picturesque place of office buildings and officials' homes built of native red sandstone. Overhanging the community is the natural-rock formation from which the agency headquarters derived its name.

In addition to the main station, numerous low-power, portable 2-way sets are installed in official field cars, trucks, and district supervisors' offices. These permit contact between agency officials and their aides far afield, eliminating former long, tiresome drives to discuss problems arising in connection with the work of rehabilitation. Aside from these, there are receiving sets in other cars and tribal "chapter" houses, and these keep the elderly Navajo leaders posted on reservation activities. Many trading posts scattered about the reservation likewise have private short-wave radios that broadcast the latest news about tribal topics.

The network's unexpected duties under the present crisis are important and include giving information on Selective Service to the young men of the tribe. It acts as a central fact-gathering medium for any unusual occurrences on the vast expanse of semiarid land, and provides agency officials with a speedy means of communication in emergencies. When the original Selective Service Act was passed, the "call" ordering the youth of the nation to register for training went out over the reservation through the central broadcasting station. Instructions were in both English and Navajo, to fully impress upon the Indian mind the need for action.

Strangely, even before the declaration of war, the appeal for registration brought many Navajos on horseback and afoot, with guns! To Young John Navajo, his country was apparently making a plea for war manpower—and he didn't want to be caught with a trusty rifle at home. Adding humor to the situation was the appearance of many an "ancient," with long-outmoded firearms, demanding a right to "take the war trail." Hadn't their eyes been trained to sight along a rifle barrel, they queried? Many wore medals presented for service with the American Army as scouts in actions recounted in the history of the Southwest. It is this spirit which has recently led to the formation—among the youthful members—of all-Indian Army units.

At registration points, during the signing up of the various age-groups, agency workers kept short-wave sending sets at their elbows to report quickly the response to the call. In any area where confusion appeared to slow down the work, additional instructions went out from broadcasting centers. This task of "rounding up" the Indians did not fall solely into the hands of the white man. In many chapter houses—the red man's replica of a community meeting hall—groups of the 72-member Navajo Tribal Council listened to requests from *Nee alneeng* and set in motion machinery that brought about completion of the registration in days, where months would formerly have been required.

Instruction of the elderly leaders in the use of the radio was fraught with superstitious obstacles. Their fear of the "little box" from which came words in their own tongue was great. At first, many stood at some distance and awaited expectantly for the wrath of the tribal gods to be wreaked on those who would have anything to do with such mystic means of communication. But they eventually came to a momentous decision. The red man's gods apparently approved of the little box, they were aiding in the mystery. These, of course, were the Wind Gods, who picked up the spoken word far away and transported it to the little box. Thus was born the Navajo's description of radio: "The Wind that Talks."

SIGNING UP

Indians, reporting to be enrolled for Selective Service by John C. McPhee, bring their guns along. On the table is a portable radio used to communicate with headquarters.

Oddly enough, just as radio is a mystery to Old John Navajo, so his white brother is mystified by the "grapevine," that reservation system of communication that carries word of tribal gatherings, misfortunes, gossip, etc., across little-traveled wastes. Some years ago, agency officials accepted the grapevine as an unexplainable but nonetheless sure means of reaching far-distant points to get in touch with tribal leaders. They would merely drop a word among Navajo visitors at *Nee alneeng* of their desire to discuss certain problems with this or that council member, and not many days later he would appear at headquarters, all unheralded.

Now the grapevine is being supplanted by the radio; requests for leaders for conference, announcement of tribal sessions, or other matters of importance to those on the reservation are broadcast daily from the central agency. Formerly, when full operation was possible, the programs included topics of world interest, particularly at the start of the war in Europe.

Hosteen Ayze Begay, a middle-aged tribal member who has in numerous ways helped to promote the Government's work among his people, became one of the first Indian broadcasters. He mixed commentaries on tribal matters with jokes in the Navajo tongue. He also joined in dramatic skits that were designed to explain to the Navajo audience the meanings of new regulations. Sound effects came extemporaneously from this combination of Winchell and Benny. He imitated hoof beats, groans of injured persons in wagon-car collisions, and grew vituperous in references to "Moustache Smeller"—as Hitler is known to the Navajos.

In other programs, tribal leaders would gather at Window Rock for round-table discussions of reservation problems, their decisions and explanations being carried over the air waves to hundreds of persons gathered at trading posts, chapter houses, or in hogans, wherever receivers were available. Yes, even hogans—those timber-and-mud huts that still shelter Mr. and Mrs. Navajo and family—had radios and became the centers of weekly neighborhood gatherings for the purpose of hearing the mystic little box in operation. Later, these turned into a sort of community "field day."

There are about twenty portable 2-way sets available for the use of field crews. As these sets are always on the move, a record of their locations is kept and supplied to central-agency officials and crew leaders who might find need for them. They are of inestimable benefit to medical units continually on the alert for outbreaks of contagious diseases that might spread quickly unless the sources are promptly located and control methods instituted. Where once the medical field worker had to rush to the nearest telephone in such an emergency, or return perhaps over great distances to the central agency, nearby sending sets now permit speedy communication with headquarters for reports and requests for supplies.

THE NAVAJO AIR COLUMNIST

Newscaster Hosteen Ayze Begay before the microphone in the broadcasting station at Window Rock, Ariz.

Much as superstition had to be overcome with the radio, so did Indian Service medical men, not so long ago, face the handicaps imposed by the stolid red man's fears of the white man's medicine and his preference for the ministrations of untutored "medicine men" of his tribe. One medico, whose name has been lost but whose wisdom will never die from the early-day annal of the service, accomplished the following through strategy: Informed that a Navajo man lay near death, he went to the family hogan to make an examination. There an Indian medicine man was attempting to banish the evil spirit which had inhabited the patient's body, but with little avail. He was obstinate in denying the physician permission to touch the patient. After a long argument, he finally consented, but when the doctor found need for immediate removal to a hospital for an operation, the medicine man again set up an argument. With a stroke of genius, the service physician answered: "If you will go with me to the hospital, I will dress you in the white robe I wear and will allow you to stand at my side while I operate." Apparently conscious of the prestige which would be attached to this, the tribal doctor consented, and the operation was successfully performed.

A long series of such superstition-breaking methods have gradually broken down the barriers set up against white medicos. This was climaxed several years ago when four of the leading medicine men appeared at the dedication of the Fort Defiance, Ariz., base hospital and joined in the ceremonies. With sacred meal and chants, designed to protect the Navajo Medical Service from evil spirits, they removed from the tribe's mind any remaining suspicion of the white man's medicine and put their "blessing" on the project.

Aside from the uses of the short-wave radio network mentioned, the reservation has established its own homefront defense plan. Emergency units of ambulance corps, plane spotters, and similar war-born civilian groups have already been or are being formed, for the wide untraveled expanses of the reservation could, with little stretch of the imagination, become landing spots or hideaways for enemy aircraft, undercover radio stations, or other Fifth Column activities. Thus, any untoward event occurring on the Navajo's homefront is reported to tribal chapter leaders, who pass it along to district supervisors, who, in turn, radio it to the central agency. When the personnel is available, a 24-hour standby service is maintained.

The standby service is especially on duty during the months when the forest-fire hazard is greatest. Reports of fires transmitted by portable sets to the central station are broadcast to the crews in the area and send them speeding to the scene. The effect of the control work, or requests for additional fire fighters, likewise come through the portable sets. During recent years this service has cut losses in reservation forests to a minimum. And so, when Young John Navajo returns from the wars and takes up his duties in rehabilitating the rangelands of his fathers, "The Wind that Talks" will no doubt take its place in his daily routine as it has in that of his dial-twisting white brother.

Spread of Knowledge Slower

THE Union of South Africa has appealed to the United States post-office authorities to help break the famine in technical books that exists there. Not only is the Union completely shut off from receiving technical literature from Axis-occupied countries but it is also subject to local restrictions on imports that have caused a real dearth of information regarding new technological and industrial developments in Great Britain and the United States. For some time past, parcel-post consignments from Great Britain have been limited to one shipment per week of not more than 4 pounds. Recently the regulation was also applied to imports from the United States. This means that libraries and educational institutions that have been accustomed to receiving hundreds of volumes monthly are now getting a mere handful. Inasmuch as South Africa is greatly expanding her war industries, she is especially interested in obtaining helpful literature from abroad.

The slowdown and, in some cases, the stoppage in the exchange of published material among the nations of the world forecasts a veritable flood of shipments when the war is over. In 1886, all leading countries signed a convention which provided for an interchange of legal and technical publications issued by their governments. This is done through the medium of the "International Exchange Service." Following the first World War, during which the exchange was not hindered to anything like the extent that it is today, there was a vast increase in consignments as soon as fighting ceased. During the year ended June 30, 1921, South Africa received 188 boxes from Germany and sent 691 boxes in return.

There are far more technical books and magazines printed now than there were 25 years ago, so the task of distributing them after the cessation of hostilities will be a tremendous one. Unfortunately, the shortage of paper in the United States has compelled private publishers of trade journals and books to curtail quantities, and it is certain that in the case of trade journals, at least, there will be few surplus back issues to export to nations that are now on the black list. No doubt the enemy countries are feeling the same pinch.

Our Deep-rooted Future

THE current demonstrations of the appalling effectiveness of aerial bombing for reducing surface structures to wreckage and rubble are likely to have a far-reaching influence on the physical aspects of future industrial building. No matter what sort of a peace is written, or what measures are set up to enforce it, nations will not soon forget the havoc wrought by the winged messengers of death and destruction and are bound to plan new construction with their minds on what happened at Rotterdam, Coventry, Cologne, Naples, and a dozen other bombing focal points.

Many large urban communities began several decades ago to put their utilities and some of their transportation facilities underground. Although protection from military attack was not even thought of at that time, some of these subterranean openings have served as welcome havens to the citizens of London, Berlin, Moscow, and elsewhere during the past four years. Since the war began there has been a definite tendency to burrow into the earth. It is common knowledge that Germany built hangars and perhaps also airplane factories underground. Gibraltar was made impregnable from the air by honeycombing it with caverns carved out of solid rock. Malta survived hundreds of terrific poundings solely because its populace could quickly take cover under the surface. Chungking similarly has been able to carry on essential activities, even newspaper publishing, because its industries dug into the good earth.

In England there are numerous underground factories that work around the clock, undisturbed by thoughts of the pulverizing effects of bombs. One of them has 2,600,000 square feet of floor space, with corridors ranging up to ¾ mile long. Fluorescent lamps simulate daylight, fresh air is drawn in from the surface, and the temperature is maintained at just below 70°F. the year round. Employees, more than two-thirds of them women, live aboveground in six new hostels, each capable of accommodating 1,000 persons. Aside from these structures there is little evidence of the presence of thousands of persons. So far as curious enemy eyes can perceive from the air, beneath them lies a bit of typical English countryside, with hedgerows and spinneys bordering the roads. The entrances to the factory are hidden, and the air passageways are curved and inclined, their portals being protected to prevent a chance bomb hit from penetrating the workrooms.

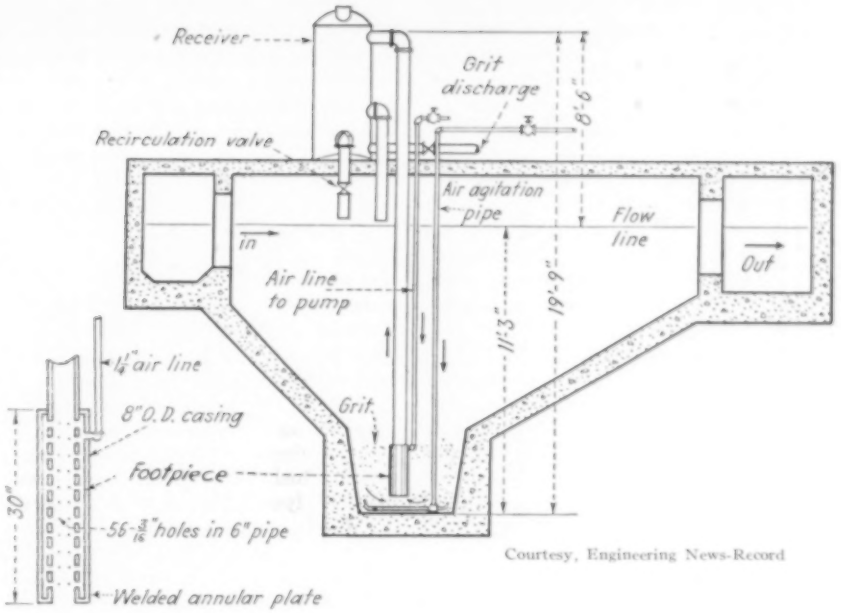
This subterranean establishment, as well as others, was located in an abandoned mine. A million tons of stone was crushed to make concrete for reinforcing walls, pouring level floors, and building machine foundations. Wells were sunk to provide an independent water supply, generators were set up to furnish lights in cases of emergency, and the walls and roof were sprayed with a binder to prevent dust from getting into machines and noses. The working level is connected with the surface by eight elevators. It is reported that the cost of construction was one-quarter less than it would have been if the same facilities had been set up aboveground.

Advertisements sponsored by manufacturers of excavating machinery and visualizing the future industrial plant as a multifloored structure reaching far into the ground are already appearing in English trade journals. Will the new aerial warfare make the skyscraper an outmoded structure and transform us into a horde of gophers reminiscent of our cave-dwelling forebears?

Air Lift Removes Grit from Settling Tank

IN WEIGHING the merits of two different systems for washing and removing grit from the settling tank of the Olean, N.Y., sewage-disposal plant, the decision was in favor of the air lift, as against a mechanical device of the conveyor type. The latter would have involved an expenditure of $5,000 and, even so, would not have served the purpose fully. The air lift was built at a cost of only $75 largely from scrap, and entailed no other outlay because a portable compressor, delivering 105 cubic feet of air per minute, was already available.

The system is shown in detail in the accompanying drawing and involves the use of two air lines, one feeding air to the bottom of the settling tank to agitate the material and the other to force the admixture of water, grit, etc., into a receiver at the discharge end of the air lift. There the fluids and solids are separated, the water flowing back into the settling tank while the grit passes out by way of a pipe in the bottom of the receiver.



Courtesy, Engineering News-Record

Before the installation of the air lift, it took six man-days of labor a week to remove the grit and sewage solids. Now only the grit enters the settling tank and is withdrawn in approximately half an hour. A larger compressor, one with a capacity of 200 cfm., might do even a better job. Be that as it may, the method is a big improvement over hand-work and is said to handle even large towels with ease.

Crewless Cargo Boats Propelled by Remote Control

WHAT next! Crewless concrete ships, sealed like submarines when cruising underwater or running with their decks awash, may before this war is over supply our overseas forces and allies with food and fighting equipment. This is more than a pipe dream, for the theories involved have already been tested by means of a 91-foot model appropriately named *Phantom*. The latter was launched late last year at the Tropical Marine Ways yard at Riviera, Fla., and proceeded under its own power through inland waterways to Washington, D. C., covering the distance of 1,040.4 nautical miles in 165 hours and 15 minutes, running time.

How are these vessels to be navigated? By remote radio control from any kind of manned water- or air-borne craft such as a dirigible, corvette, destroyer, or even a submarine. The possibility that the radio signals might be jammed by the enemy has not been overlooked, for codes and secret devices have already been invented to prevent such interference.

NO MORE ELECTRIC SHOCKS

This is a picture of a Carborundum blasting booth showing short lengths of brass chain hung over the ports through which the operator must insert his arms to do his work. By this simple expedient, which was devised at the Schenectady, N.Y., works of the General Electric Company, the discharge of static electricity between the workers' arms and the blasting enclosure is eliminated.

Waterproof Matches

MATCHES that will still ignite after four hours of submergence have been produced by the U.S. Bureau of Standards in coöperation with the Quartermaster Corps. They were developed primarily for our fighting men who now carry in a waterproof box the ordinary type that can be struck most anywhere, provided it is not wet. Once the container has been opened in the hot steaming jungle or aboard ship, the matches absorb moisture and quickly become useless. The heads of the new kind are covered with a water-resistant solution; and under test in a chamber in which tropical conditions were simulated they have remained effective for five days when subjected to a temperature of 100°F. and a humidity of 95 per cent—almost dripping.

Here is something that prospectors, geologists, explorers, trappers, fishermen, etc., especially in the frozen regions of the world, will be interested in, for men have been known to freeze to death for lack of a dry match with which to light a fire. An experimental order has been placed; and if the matches meet requirements they will be manufactured in quantity. Lighters are not issued to service men.

Industrial Notes

Treating cotton rope with a toxic preservative prepared by I. E. Laucks, Inc., is said to give it firmness and resistance to salt water, wear, and unwinding, thus making it suitable for naval and maritime use.

Since its completion in 1941 in Switzerland, what is claimed to be the world's first gas-turbine-driven locomotive has been run at speeds up to 79 miles an hour, exceeding the expectations of its builders. The turbine has a maximum capacity of 2,800 hp.

For washing factory windows, skylights, saw-tooth roofs, etc., the Berman Chemical Company is offering a cleaner that is said to dissolve varying deposits instantly for removal by flushing with water. It contains no soap, lye, or caustic and is not injurious to hands, clothing, and drains.

The Goodyear Tire & Rubber Company has put into quantity production a rubber heel that is said to carry off static electricity just about as soon as it is created within a worker's body. By preventing its accumulation, the danger of generating sparks that might cause explosions in munition plants, hospitals, etc., is averted.

Since the installation of a special safety guard on emery-wheel grinding machines in shops of the Carnegie-Illinois Steel Corporation, eye trouble resulting from flying sparks or particles of emery have been unknown. This claim is made for the protective device after long use under service conditions. The shield, shown below, is the invention of C. R. Jeffreys, general tool foreman at the company's Clairton, Pa., works. It is made up of a sturdy framework and of plastic windows that will not break under the bombardment of hot sparks. The guard is swivel mounted so it can be adjusted as desired over the emery wheel and is provided with side wings. It affords protection from all working angles against sparks that have been known to travel as far as 20 feet from the stone, thus endangering not only the machine operator but also passersby. The shield can be attached to any existing machine and requires no maintenance other than possible window renewal.

For the emergency treatment of workers suffering first- and second-degree burns there is available a tannic-acid solution, called Tannic Spray, that is put up in a spray-type container ready for quick application. It is said to be a stable antiseptic that covers the affected area with a protective film, thus lessening the chances of blister formation and infection.

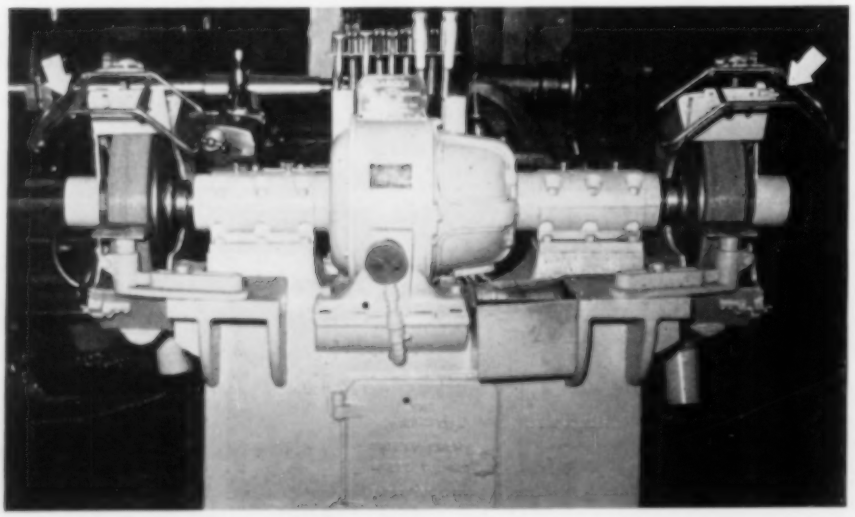
Brass, bronze, and copper parts in which broken pieces of taps and drills have become embedded can be salvaged, it is claimed, by the use of an acid that has recently been put on the market. The acid is diluted with water and is heated in a glass or lead container to a temperature of 150 to 200°F. In the case of small tool bits, approximately fifteen minutes of immersion is sufficient to eat them away, leaving the other metal unaffected.

For testing compression springs up to 2½ inches in diameter and 7 inches long, P. A. Sturtevant Company is offering a new tool that can be used for measuring the recoil pressure of a spring compressed to any predetermined length, to match sets of springs with precision, etc. Compression is effected against a rigid platform by a lever in the form of any accurate standard torque wrench, which also serves as a measuring instrument. A sound device indicates when the spring has been compressed to the test point,

and when that is reached the operator takes the reading from the scale or dial on the wrench. The unit is of the bench-mounted type and, being low in cost, permits the establishment of numerous check-up and inspection stations throughout a plant.

A patent has been assigned to the Wright Aeronautical Corporation on a pneumatic booster pump for high-altitude aircraft that is designed to overcome the resistance offered by long fuel lines and to prevent vapor lock. The unit is installed at the tank outlet and may be driven by air at low pressure supplied by a small engine-driven compressor or by the engine supercharger. The service requirements of such a pump are rigid. It must not be overheavy; must furnish pressure substantially in proportion to the pressure by which it is operated; must feed the gasoline at a rate not exceeding fuel demands; and must do all this with the least possible agitation of the gasoline, with a minimum of pulsation in delivery, and under snap-action valve control.

Liberty freighters are to be equipped with plywood lifeboats, a departure in maritime practice that has in the past specified steel for their construction. The new boats, 1,000 in number, are being built of sections that are formed by an ingenious method devised by architects. Veneer strips, 6 inches wide and covered with waterproof, low-temperature phenolic-resin glue, are laid diagonally in a criss-cross pattern in molds and are simultaneously bonded together and shaped by pressure applied by inflated rubber balloons. Just how this is done is not divulged. According to the U.S. Department of Commerce, each plywood lifeboat represents a saving of approximately 2,000 pounds of metal. It is nearly half a ton lighter than a steel vessel of equal size and has 7 inches more freeboard when loaded to capacity.



How rubber prevents a building B-O-O-M

A typical example of B. F. Goodrich development in rubber

THE spark that jumps from your hand to the door knob when you cross a carpeted room could make a chemical or powder plant blow up.

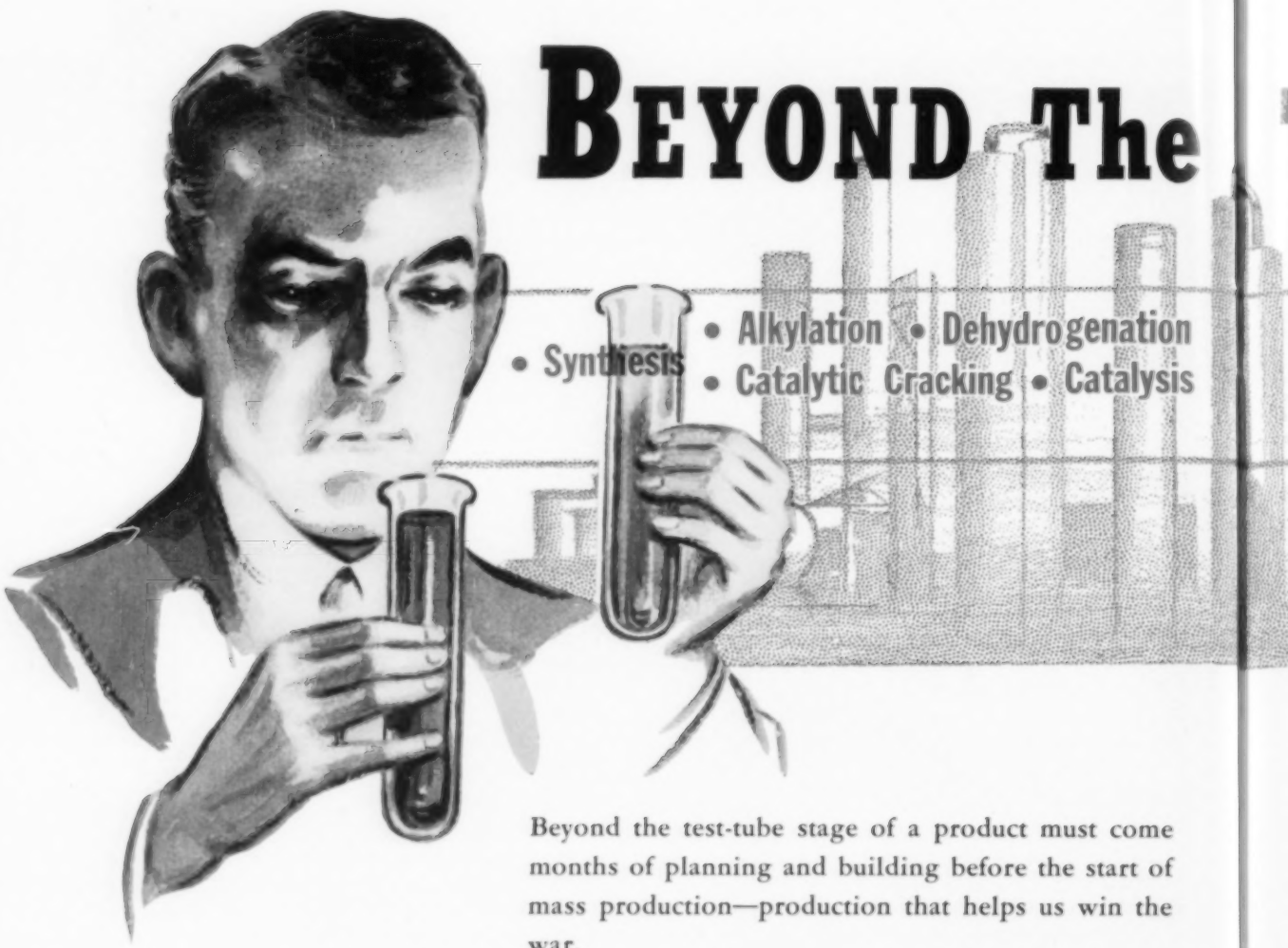
In factories, rubber V belts—like the one that turns the fan in your automobile engine—rub against the metal pulleys and build up this static electricity. Because rubber is an insulator and does not conduct electricity, the static stayed in the belts and built up until it was strong enough to jump—*and spark*. Then, if powder, chemical or gasoline was in the air—B-O-O-O-M! Unless belts could be made of some material that would let the current flow away as it flows through a copper wire the danger of explosion would never be far away.

B. F. Goodrich development men went to work to change the very nature of rubber. They found they could add chemicals to rubber that would make it conduct electricity but made it too stiff to use. The problem became one of finding a rubber so soft that the added chemicals stiffened it to the exact degree for use. Finally they found the ideal combination. The result was a rubber compound that has *one billion times* the ability of ordinary rubber to carry electricity.

Belts were made of this new development and today these B. F. Goodrich static-discharging V belts are at work in powder and chemical plants all over the country. Here is another example of B. F. Goodrich development for war that will serve in peace, too—safer compressors in gasoline stations, and no static shock from your washing machine. And there are other uses that you might want to investigate for your product or plant. *The B. F. Goodrich Company, Industrial Products Division, Akron, Ohio.*

B.F. Goodrich

RUBBER *and* SYNTHETIC *products*



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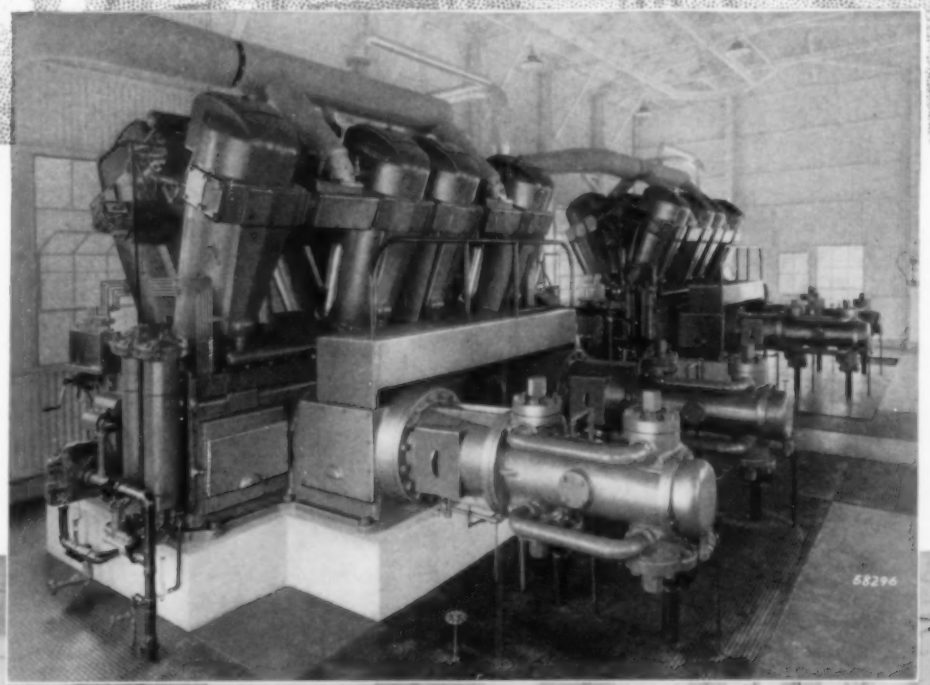

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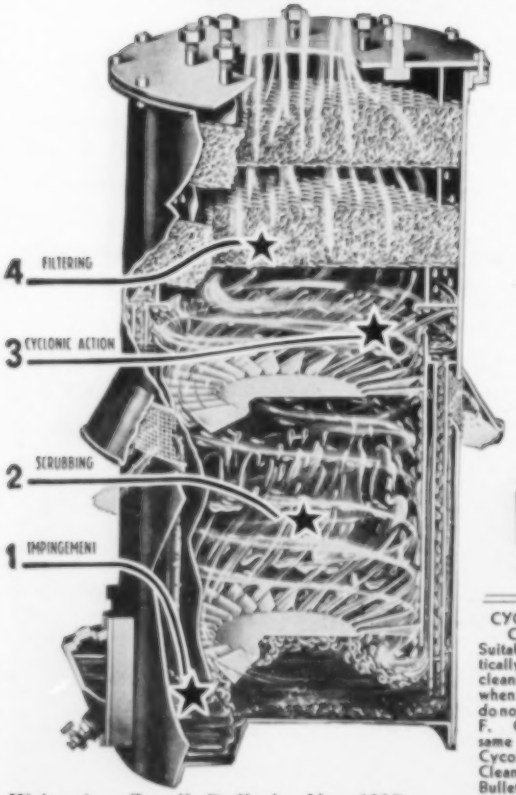

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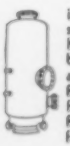

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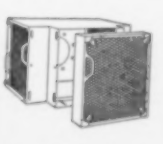

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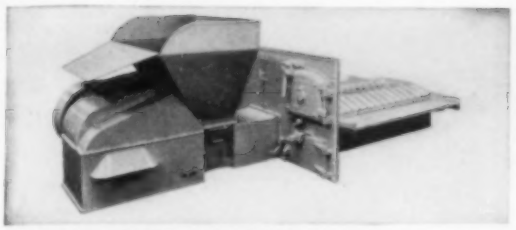
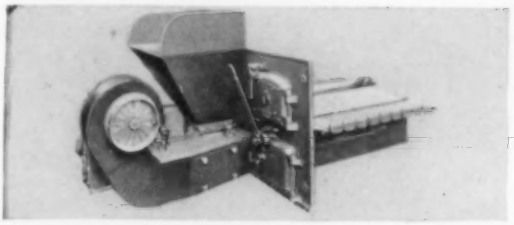
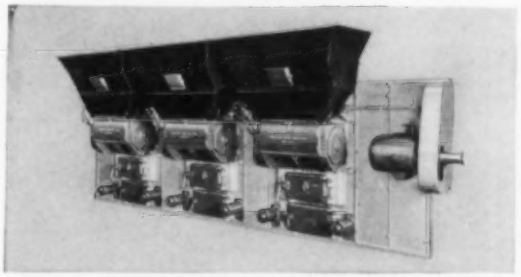


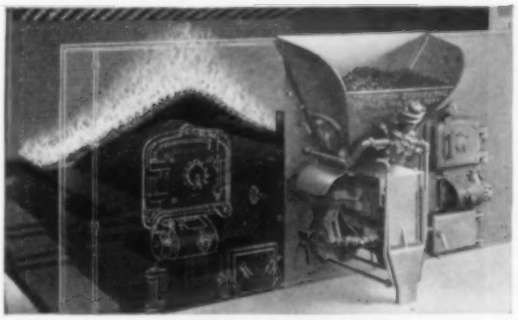
C-E SKELLY STOKER



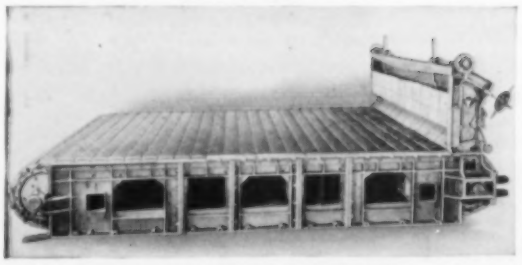
C-E LOW RAM STOKER



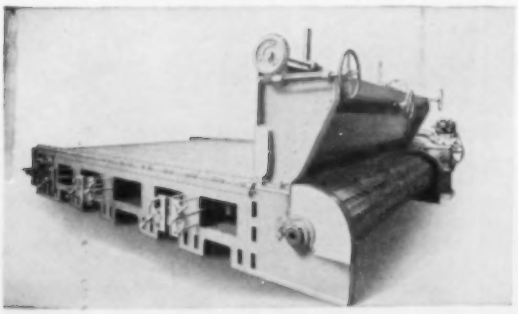
C-E SPREADER STOKER



C-E TYPE E STOKER



C-E TRAVELING GRATE STOKER



C-E CHAIN GRATE STOKER

IF YOU'RE THINKING OF

CONVERTING TO COAL

...better do it now!

Make no mistake about it, conversion from oil to coal firing is going to continue. The reasons are just as compelling today as they were a year ago. Right now there's barely enough time left to convert before the late Fall heating load will increase fuel consumption. Those who act promptly will be ready. Those who don't will find themselves facing delayed deliveries of equipment.

CONVERSION MEANS SAVING

Fortunately, converting to coal isn't just a nuisance and an expense. In fact, for those people who obtain the *right* kind of installation it can prove a blessing in disguise. Besides avoiding interruptions of vital heat and power service, coal firing is more economical in the long run. Hence the *right* conversion job can be a source of saving not only during the present emergency but long after the war is over.

HOW TO GET A GOOD CONVERSION JOB

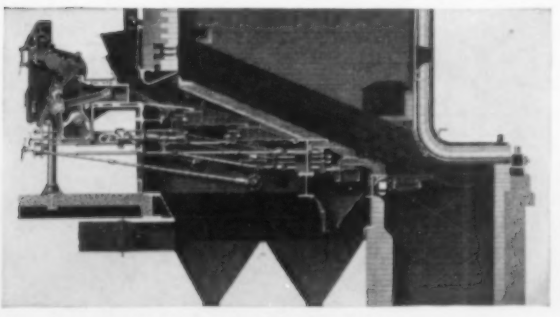
To be sure of getting a good conversion job, let Combustion Engineering survey your plant and make a recommendation. From the C-E line of stokers — the most extensive on the market — you will be sure of getting the right type of installation for your needs — and you will get the benefits of nearly half a century of experience in the stoker field, plus the "know-how" acquired from many hundreds of conversion jobs completed within the past year.

WRITE, PHONE OR WIRE TODAY
Your inquiry will be referred to our District Office nearest you for immediate attention.

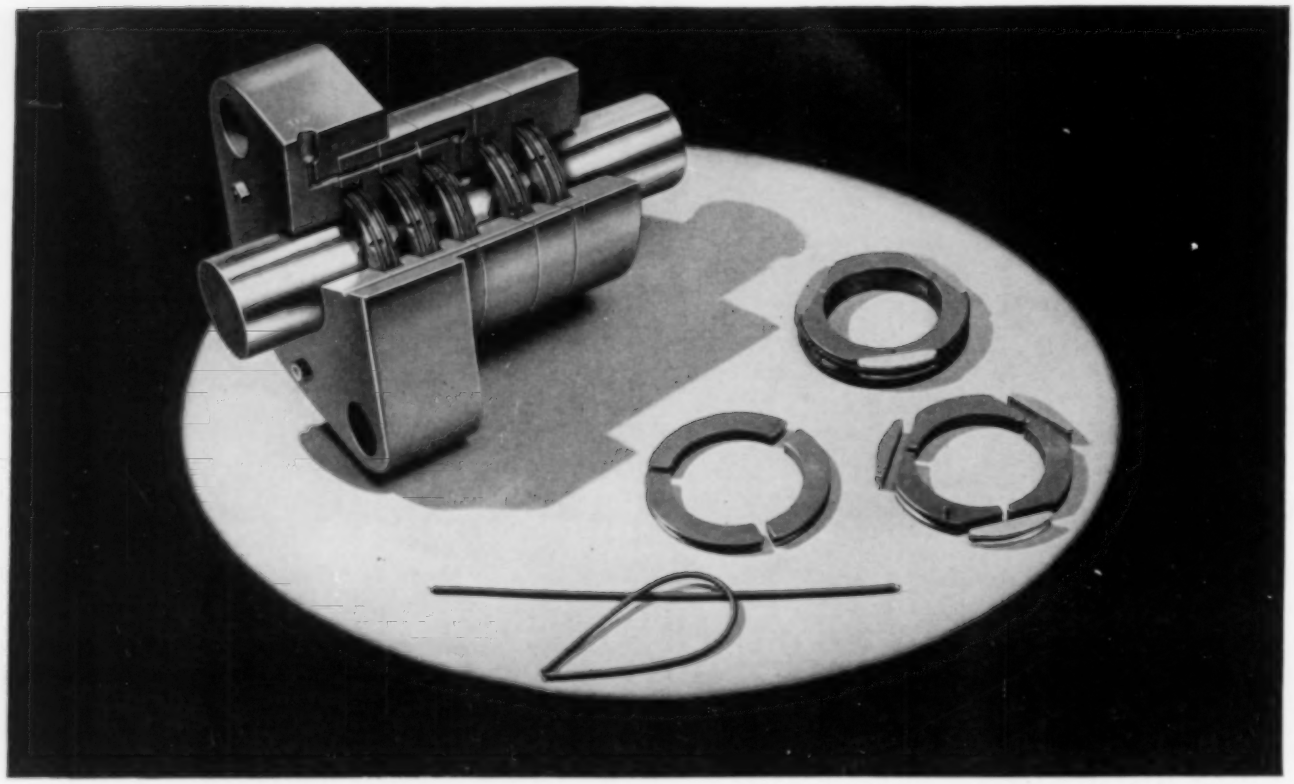
COMBUSTION ENGINEERING

200 MADISON AVENUE, NEW YORK, N. Y.

A-739



C-E MULTIPLE RETORT STOKER



PRECISION

COMPRESSOR ROD PACKINGS

MORE HORSEPOWER AT LESS COST is the net result when your engine or compressor is equipped with COOK'S Precision Metallic Packings. Here's why:

Precision construction assures positive seal of the pressure.

Basic design allows for rod misalignment and vibration, without added friction and wear, provides automatic compensation for wear and guarantees a constant oil film between rings and rod.

Regardless of the make or type of your equipment you can have the improved operation and years of repair-free service COOK'S Precision Packings bring, because there is a proved type and material for all prevailing pressures and temperatures. Shown above is the annular cup type.

Many engine and compressor manufacturers supply COOK'S Packings as original equipment—others furnish them on request. So, when ordering new equipment, specify COOK'S Packings.

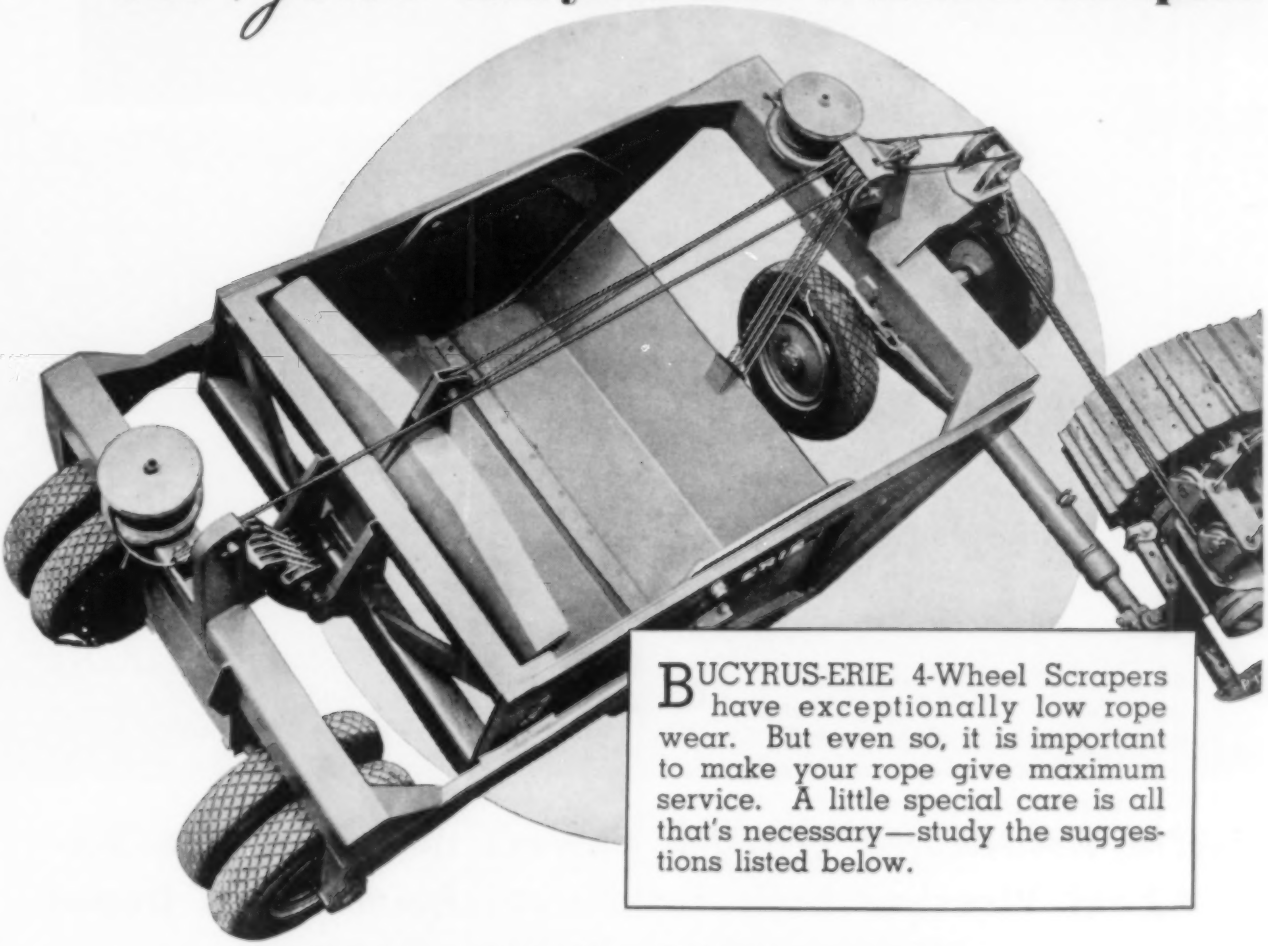
For equipment in service, write or call our nearest office.

C. LEE COOK MANUFACTURING CO., Incorporated, Louisville, Kentucky. Branch Offices and Representatives—Baltimore, Boston, Chicago, Cleveland, Houston, Los Angeles, Mobile, Montreal, New Orleans, New York, Portland, Oregon, San Francisco, Seattle, Tulsa.

"Sealing Pressures Since 1888"

COOK'S METALLIC PACKINGS

It's *Easy* To
PROLONG ROPE LIFE
on your Bucyrus-Erie 4-Wheel Scrapers



BUCYRUS-ERIE 4-Wheel Scrapers have exceptionally low rope wear. But even so, it is important to make your rope give maximum service. A little special care is all that's necessary—study the suggestions listed below.

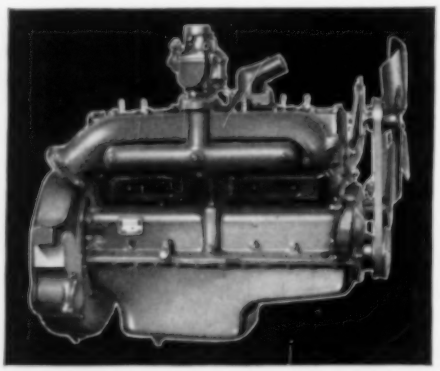
FOLLOW THESE SIMPLE RULES

1. Check all the cable leads regularly to see that ropes are properly aligned to prevent any undue rope wear.
2. Disassemble and clean the sheaves regularly so as to keep them working smoothly and prolong their life.
3. Replace sheaves when they become worn to a point where they may damage rope. Bucyrus-Erie sheaves are identical and interchangeable on most models.
4. If a sheave-stand becomes bent be sure to straighten it immediately, before the off-lead damages or cuts the cable.
5. Save cable by avoiding unnecessary stress. Do not travel with ejector, apron or bowl hoisted to extreme height.
6. Your International TracTracTor Distributor is equipped to do a service job as never before to help you prolong the useful life of your equipment.

BUCYRUS ERIE TRACTOR EQUIPMENT

SEE YOUR INTERNATIONAL TRACTRACTOR DISTRIBUTOR

WHERE THE NAVY HAS TO NAVIGATE RUGGED TERRAIN



...a WAUKESHA ENGINE powers this *Available* Six-Wheel Wrecker built for Naval Ammunition Depot

★ Any job that the Navy gives to a wrecker anywhere around a naval ammunition depot is a tough job. Whether it's handling big shells . . . huge guns . . . or one of the many general utility jobs . . . it's always heavy hauling!

But when the terrain around that depot is "rugged" that wrecker had better be built like a battleship *and powered accordingly.*

This six-wheeler is. Specially built by Available Truck Co., Chicago, for this particular Navy job . . . it is *powered with a Waukesha Engine.* Super-power . . . smoothness . . . speed . . . stamina—with dependability.

That's why Waukesha Engines power so many war vehicles of the very latest type.

For Automotive, Industrial and Stationary Power, Waukesha Gasoline and Oil Engines range from 5 hp. to over 300 hp. Get Bulletin 827.

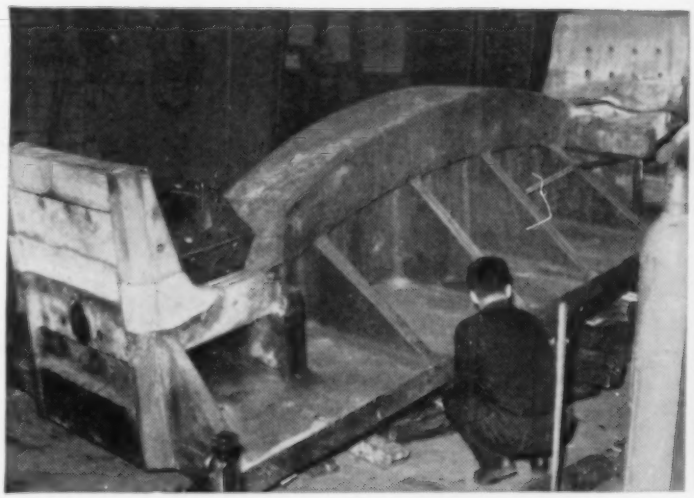
WAUKESHA MOTOR COMPANY, WAUKESHA, WIS.
NEW YORK • TULSA • LOS ANGELES

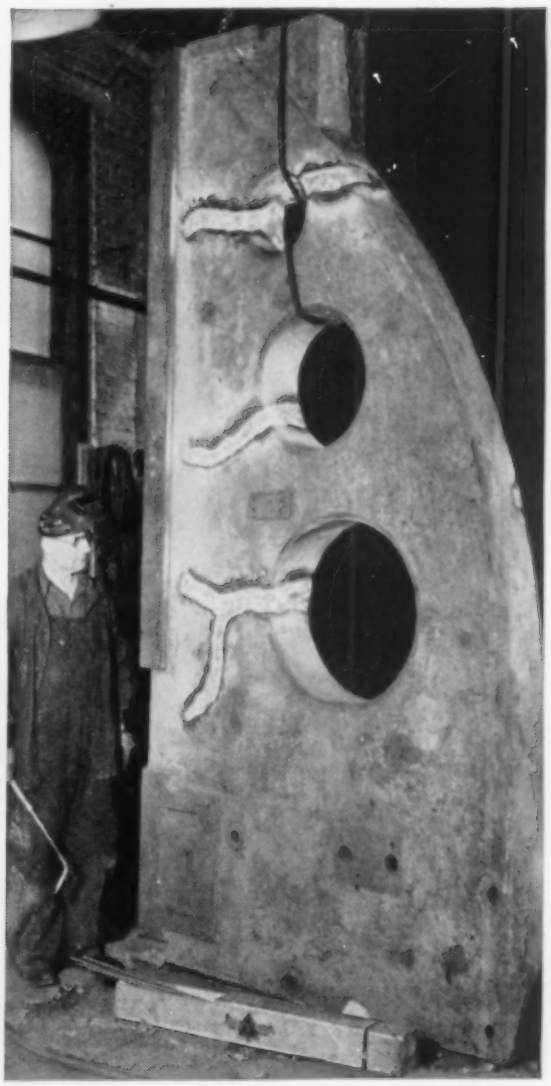
★ ★ ★ FOR VICTORY . . . BUY WAR BONDS AND STAMPS ★ ★ ★

MORE POWER FOR VICTORY

WAUKESHA ENGINES

Credit quick BRONZE WELDING with two more outstanding repair jobs





(Left) A 14-ton ram—badly fractured—but put back into service in only 6 days . . . with 1750 lbs. of Tobin Bronze. (Right) A 2-ton section of a boring mill—cracked in four places . . . Anaconda "997" Low Fuming Rod made it as good as new—with only 39 man hours for chipping and welding.

Day by day, a lot of money is being saved in both time and vital equipment by repair welding with Anaconda Rods such as Tobin Bronze* and "997" Low Fuming. The availability of this fast, efficient method of repair gives war industries a potent aid in keeping up production. For information on welding with Tobin Bronze and 15 other Anaconda Rods, write us for Publication B-13. You'll find it especially useful at this time when prolonged equipment life is so important. 4386B

THE AMERICAN BRASS COMPANY
General Offices: Waterbury 88, Connecticut
Subsidiary of Anaconda Copper Mining Company
In Canada: Anaconda American Brass Ltd., New Toronto, Ont.

*Reg. U. S. Pat. Off.

Anaconda Welding Rods

ANACONDA

Official U. S. Army and Navy Photos

GARLOCK AT WAR . . .

97.93% of all products now being manufactured by Garlock go to war. More than half of that production enters into implements of war—and the remainder represents materials used in the maintenance of war plants. THE GARLOCK PACKING COMPANY, PALMYRA, NEW YORK.

You can't laugh off a Sixty Year Safety Record

The Genuine CROSBY CLIP

For sixty years — since 1883 — the Genuine CROSBY CLIP has proved its dependability on every kind of wire rope installation. Why take a chance when you have this proof of CROSBY SAFETY? You get all of these safety features when you standardize on the Genuine CROSBY CLIP:

1—Correct Gripping Design.
2—Drop forged steel base.
3—Oversize U-bolt and nuts.
4—Ease of application.
5—Hot dip galvanizing — sure preventive of rust and corrosion.

Write for our interesting illustrated book, "With An Eye To Safety".

AMERICAN HOIST AND DERRICK CO.
Chicago San Francisco New York
SAINT PAUL, MINNESOTA

1883 - 1943

AMERICAN TERRY DERRICK CO.
SOUTH KEARNY, N. J.

FOR SAFETY

Removes 99% plus of water, dirt and oil from compressed air

THE unusual efficiency of the Johnson-Gast Separator arises from the fact that it combines, in one simple device, the two most effective principles of separation—expansion and change of direction. As the air enters it is allowed to expand, precipitating most of the moisture. Then it passes through the "thousand baffles"—a labyrinth of coarse wire mesh—changing direction of flow many times and surrendering particles of water and dirt at every turn.

In all Johnson-Gast Separating Devices you'll find this same combination of simple design and high efficiency. The After-cooler is frequently installed ahead of the separator to condense all moisture vaporized by heat of the compressor. A typical installation is pictured here. The Oil Absorber is used for services where every final trace of oil must be removed, as in paint spraying.

Write for new bulletin

FOR USE ON STEAM LINES TOO

THE JOHNSON CORPORATION
830 Wood Street, Three Rivers, Michigan

JOHNSON-GAST
SEPARATORS • AFTERCOOLERS • OIL ABSORBERS

no pits...

no burns...no errors!

Harmful overloads are doomed to defeat when electrical circuits are protected with Westinghouse "De-ion" Circuit Breakers.

Momentary overloads are passed without interruption; but before any disturbance can become dangerous, the sensitive Bi-metal element goes to work, *quick!* The circuit's broken, the arc quenched, in the blink of an eye.

Contact points are protected against severe pits and burns. The "De-ion" arc quencher draws the arc into the chamber, divides and smothers it in half a cycle. Contacts last longer; require less maintenance. And service is just as easily restored.

Once the condition causing the disturbance has been corrected, a simple flip of the indicating handle restores the circuit . . . in seconds. No waiting for a maintenance man; no parts to repair or replace.

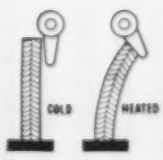
Protect equipment and circuits with Westinghouse "De-ion" Circuit Breakers. Ratings up to 600 amperes; enclosures for practically every type of service. Get in touch with your local Westinghouse representative today. Westinghouse Elec. & Mfg. Co., E. Pgh., Pa., Dept. 7-N.

J-21276

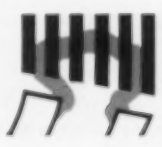
Westinghouse

PLANTS IN 25 CITIES... OFFICES EVERYWHERE

"DE-ION" CIRCUIT BREAKERS



"IN THERE PITCHING" is this Westinghouse Bi-metal element. Two metals which react differently under heat are bonded together. Threatening overloads cause this Bi-metal to bend, tripping the interrupting mechanism, opening the circuit.



CATCHING THE "HOT ONES" is the job of this "De-ion" arc quencher. Made of parallel metal plates in the form of a grid, it draws the arc into the chamber, divides it into segments and smothers it between the plates . . . all in the space of half a cycle.

The THIRD White Star Is Awarded To NATIONAL FORGE

Keeping up a winning record can be even more significant than receiving the awards that started that record. Proud as National Forge workers have been in the winning of the Ordnance "E," All-Navy "E" and Army-Navy "E," they take even greater satisfaction in knowing their sustained efforts have brought three consecutive White Star citations.

In receiving the Third White Star, National Forge holds an unsurpassed position on the industrial front for official recognition of exceptional war production output. To maintain this unbroken record, in such an exacting field as heavy duty steel forgings, calls for precision craftsmanship of the highest order as well as unabated zeal in furthering the war effort.

In its ability to sustain such maximum production with high precision, National Forge again demonstrates, we believe, that when a steel forging has heavy duty work to do it should be National Forged.

NATIONAL FORGE & ORDNANCE CO.

IRVINE, WARREN COUNTY, PENNA.

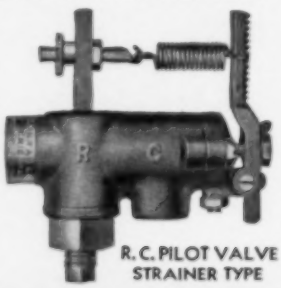
"WE MAKE OUR OWN STEEL"

For Excellence in Production

Each White Star Denotes Six Months of Sustained Productic n

R. C. PILOT VALVES FOR POSITIVE CONTROL

R-C Unloader Pilot Valves (plain or strainer type) are standard on many leading compressors . . . installed as replacements on thousands of compressors in all parts of the U. S. A. and overseas. The R-C valve—positive in action—cannot chatter . . . it's always in open or closed position. Adjustment is provided for any unload-to-load range from 3% to 30% of maximum receiver pressure. Install an R-C Unloader Pilot valve—let performance prove its value. Specify air pressure and range of on-and-off operation desired. Write for price and recommendation.

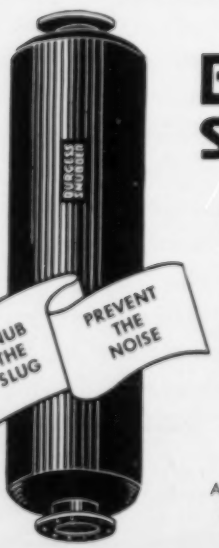


R. C. PILOT VALVE STRAINER TYPE

R. CONRADER CO.

1207 FRENCH STREET - ERIE, PA.

PILOT VALVES for Portable and Stationary Air Compressors provided with Unloaders



BURGESS SNUBBERS for Quiet Compressor Intakes

Acoustic Division, Burgess Battery Co.
2823-I W. Roscoe Street, Chicago

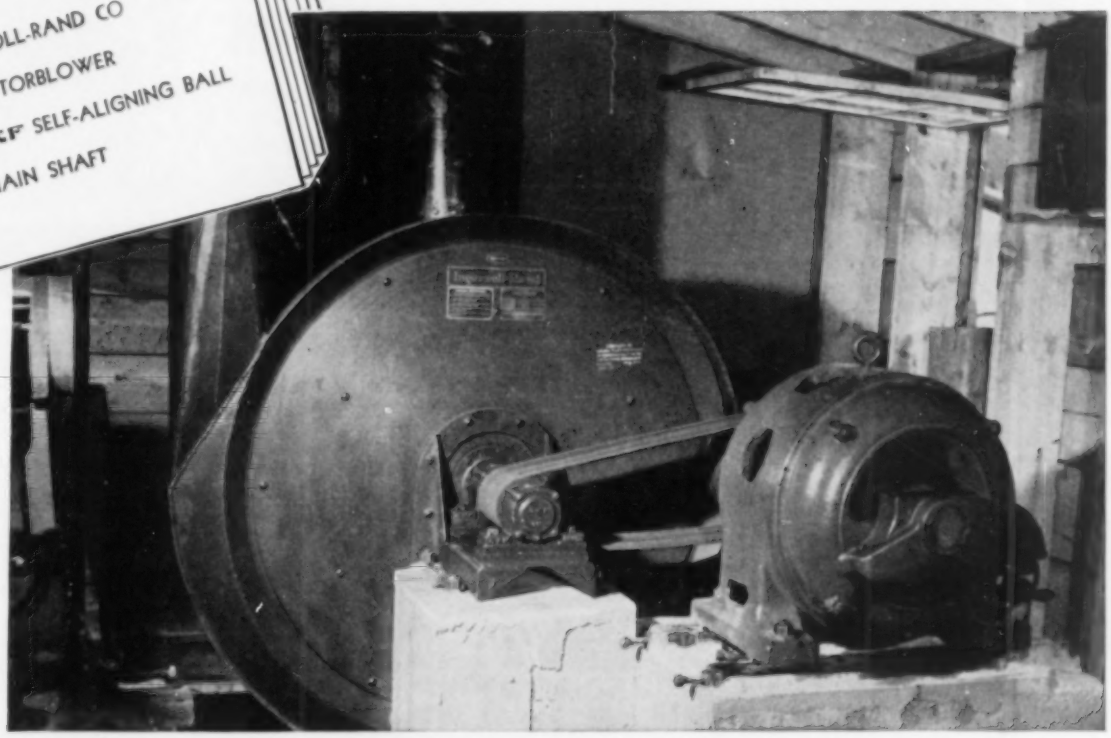
APPLICATION

Mfr. INGERSOLL-RAND CO

Machine MOTORBLOWER

Bearings SKF SELF-ALIGNING BALL

Location MAIN SHAFT



HELPING *Miners breathe*

WITH SKF BEARINGS

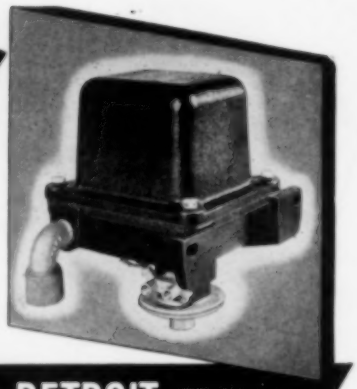
Blowing plenty of fresh air into the mines for the men is always an important task, but in these war days it's a vital necessity. Just as vital is the necessity of dependable bearings in the machine that handles the air. The SKF Bearings in this Motorblower not only insure reliable and quiet operation, but they prevent wear from slowing down swiftly turning shafts . . . and help maintain high efficiency throughout a wide operating range. When an important job is assigned to an SKF-equipped machine, it's a job done RIGHT . . . *always*. 5360

SKF INDUSTRIES, INC., PHILADELPHIA, PENNA.

ARMY E NAVY

SKF BALL AND ROLLER BEARINGS

HERE IS AN *Explosion-Resisting* PRESSURE SWITCH



● The **CLASS 9013 TYPE AR** switch is built for use in Class I Group D hazardous locations. Top pressure 225 lbs.—standard air compressor settings—with or without release valve. Ratings are 2 H.P. 110 V., 3 H.P. 220 V. single phase and 5 H.P. 220-550 V. polyphase.

SWITCH • PROTECT • REGULATE • DO IT ALL WITH SQUARE D

SQUARE D COMPANY • REGULATOR DIVISION • DETROIT

NEW YORK OFFICE
60 East 42nd Street

MAIN OFFICE
AND WORKS
BUFFALO, N. Y.

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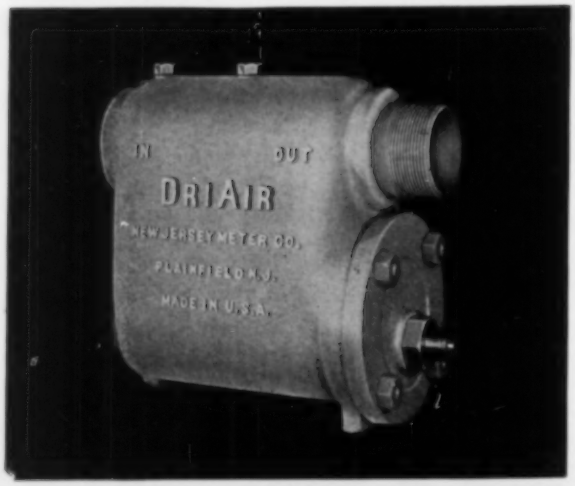
ATLAS STEEL CASTING COMPANY

OPEN HEARTH & ELECTRIC STEEL

1963 ELMWOOD AVENUE

BUFFALO, N. Y.

GREATER PNEUMATIC EFFICIENCY



DriAir may be suspended from overhead piping without any other support.

A typical installation showing DriAir standing on the floor next to the wall.

SEPARATES • COLLECTS • DELIVERS

WHEN EQUIPMENT IS PROTECTED BY

DRIAIR

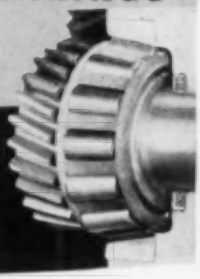
A COMPLETE SELF-CONTAINED UNIT

● DriAir separates and automatically ejects the condensed water and oil from compressed air lines, collects pipe scale and rust, delivers clean dry air to tools and other pneumatic equipment. This promotes better lubrication, reduces wear, increases life of tools and produces greater output. All internal parts are made of bronze or copper—resistant to corrosion and practically permanent.

Write for Bulletin DA which fully describes the construction and operation of the DriAir.

NEW JERSEY METER COMPANY
PLAINFIELD, NEW JERSEY

TIMKEN ROLLER BEARINGS in a SINGLE CYLINDER ENGINE?

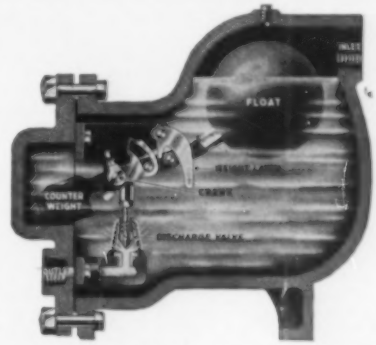


Certainly—if it's a
WISCONSIN AIR-COOLED ENGINE

No Wisconsin Engine, so far as we know, has ever had a case of "Bearing Failure." Basically, this is an end result of using Timken Roller Bearings at both ends of the crankshaft. Normally, small engines are not provided with this safeguard . . . but every Wisconsin Engine, whether single cylinder or 4 Cyl.; 1 hp. or 35 hp., has this heavy-duty service protection. This is a typical example of Wisconsin Air-Cooled Heavy-Duty Engine design and construction . . . geared to maximum utilization of power-operated equipment.

MOST POWER PER POUND

WISCONSIN MOTOR Corporation
MILWAUKEE, WISCONSIN, U. S. A.
World's Largest Builders of Heavy-Duty Air-Cooled Engines



NICHOLSON "JR"

A Compressed Air Trap Designed for Dependable and Automatic Drainage of Water and Oil from Air Tanks, Receivers, Aftercoolers, Etc.

Specially designed and constructed to provide long, trouble-free service under continuous operation. Large capacity . . . for pressures up to 125 lbs. . . . intermittent discharge . . . welded stainless steel float . . . water sealed discharge valve . . . made in one pattern size only with either ½", ¾" or 1" inlet and ½" outlet. Bulletin No. 341.

W. H. NICHOLSON & CO., 180 OREGON ST., WILKES-BARRE, PA.

NICHOLSON *Traps*
THERMOSTATIC ▼ PISTON AND WEIGHT-OPERATED STEAM
GASOLINE AND COMPRESSED AIR TRAPS ▼ ▼ ▼
CONTROL VALVES ▼ FLOATS ▼ MANDRELS ▼ STEAM AND AIR SEPARATORS

In time of war and in time of peace

Wagner MOTORS

reflect sound engineering and modern manufacturing methods

The skill and facilities Wagner has gained in 52 years of manufacturing quality motors are now being used to speed up Victory.

Wagner compressor and pump motors are built in a wide range of types and sizes with electrical and mechanical characteristics varied to meet all your requirements.

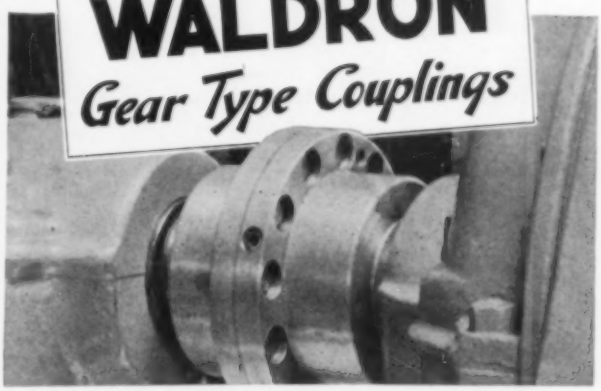
If you need motors for equipment that is helping to speed up war production, consult the nearest of Wagner's 29 branch offices. These offices, located in principal cities, are manned by trained field engineers competent to solve your motor application problem.

Send for Complete Information

Bulletins MU-182, MU-176, and MU-183, describing and illustrating the complete line of Wagner motors will be sent upon request.

Wagner Electric Corporation
ESTABLISHED 1891
6418 Plymouth Avenue, St. Louis, Mo., U. S. A.
ELECTRICAL AND AUTOMOTIVE PRODUCTS

VITAL INDUSTRIES SPECIFY WALDRON *Gear Type Couplings*

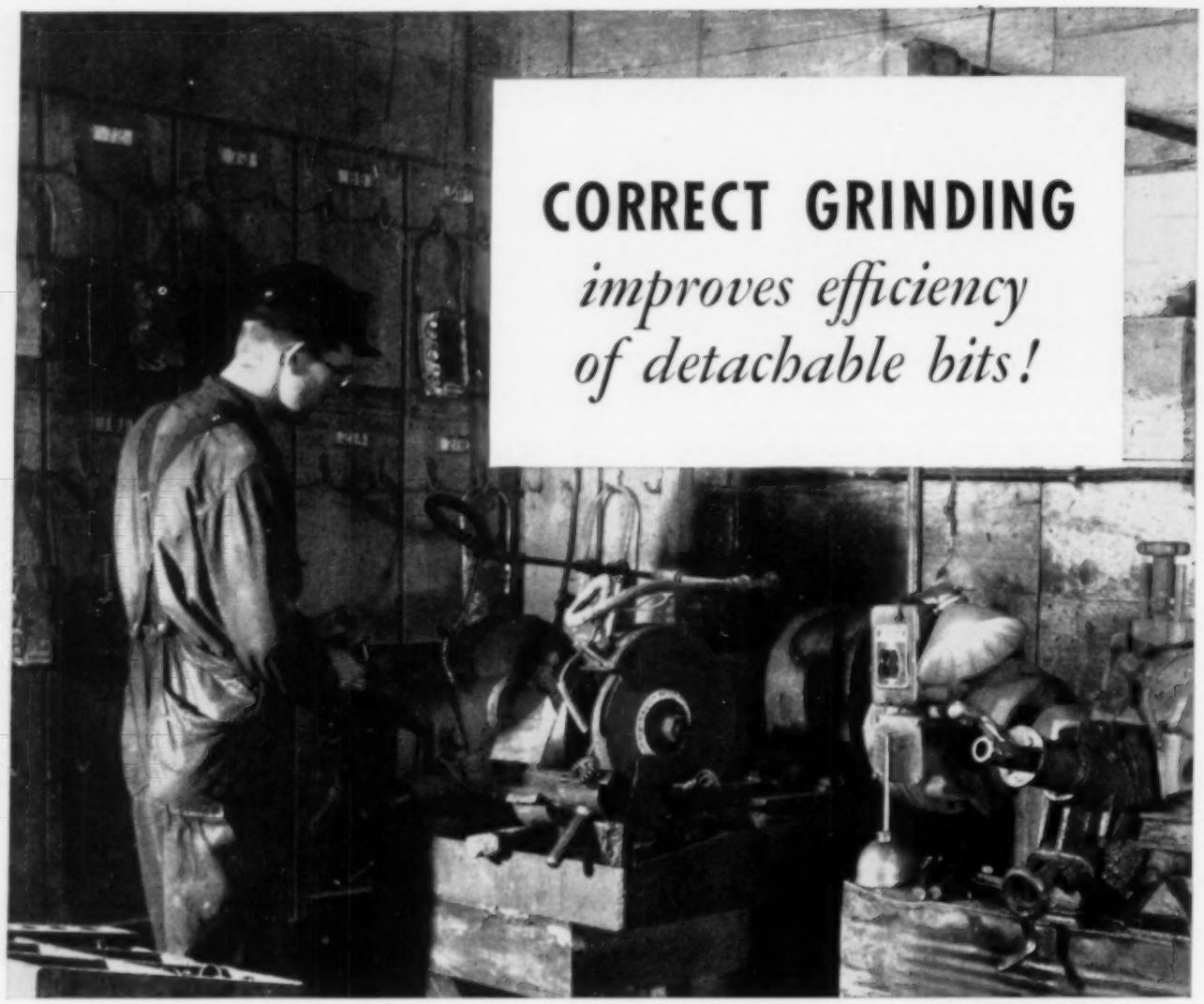


Exclusive Operating Advantages

To guard against operating shutdowns for frequent lubrication, repair or replacement of couplings, the dependable Waldron Coupling is in tremendous demand. Its forged steel parts, positive dust and oil seal, longer lining up surface of hubs, automatic lubrication—are some of the advantages of its advanced design.

Although war work needs must receive first attention, we invite your inquiry.

Manufactured and Sold by the
JOHN WALDRON CORP.
NEW BRUNSWICK, N. J.



CORRECT GRINDING
improves efficiency of detachable bits!

In wartime, or anytime, there are two important things to know about detachable bits: (1) *What* their advantages are; (2) *how* to get the most out of them.

Detachable bits save on steel-shop costs and reduce nipping charges. They eliminate carrying steel in and out of working places, permitting more time for drilling. Bits drill faster than ordinary steel drills and are safe for use in stopes and raises. Rod lengths and bits can be standardized. Bits work well in muddy or soft ground. A simple forming and gauging operation is all it takes to make a used detachable bit ready for service again. No forging, no re-tempering is required.

To get the most out of detachable bits, it's important to *keep them properly ground!*

And that means using the right grinding wheels for forming and gauging. One way to be sure of getting the right wheel is to use one especially made to hold its shape, and to cut fast, free and cool. That's how you get accurate gauge and form . . . longer tool life between grinds . . . reduced grinding time . . . and lower cost per grind.

We ask you to remember that every grinding wheel today is a "Weapon for Production." Use it wisely and it will serve you better!

CARBORUNDUM
ABRASIVE PRODUCTS

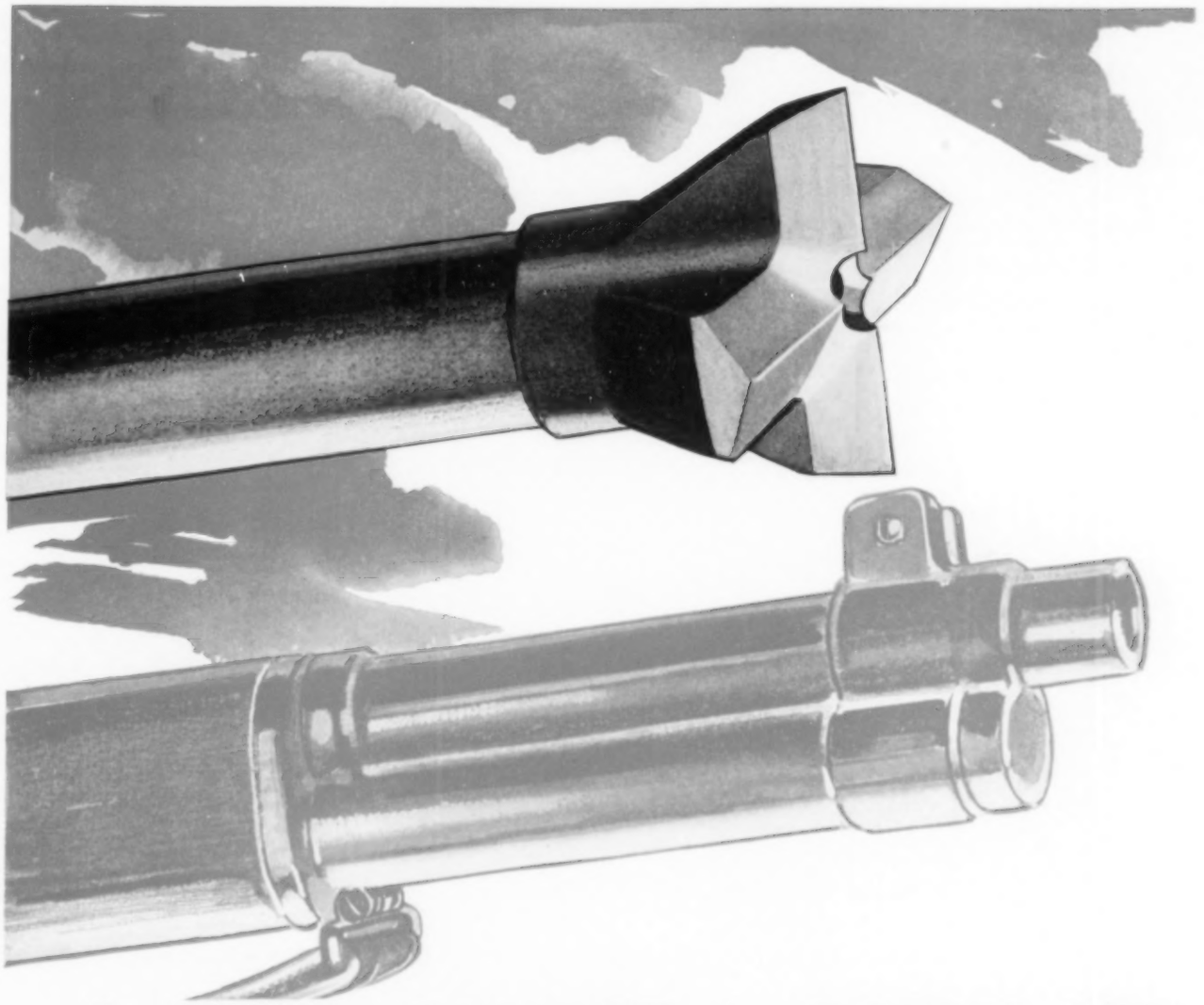
THE CARBORUNDUM COMPANY, NIAGARA FALLS, N. Y.

REG. U. S. PAT. OFF.

MANUFACTURERS OF GRINDING WHEELS, COATED ABRASIVES, SUPER REFRACTORIES, HEATING ELEMENTS

Sales Offices and Warehouses in New York, Chicago, Philadelphia, Detroit, Cleveland, Boston, Pittsburgh, Cincinnati, Grand Rapids

(Carborundum is a registered trade-mark of and indicates manufacture by The Carborundum Company)



The RIGHT CALIBER *for* EVERY JOB

When drilling rock, it is just as important to have the right size and type of bit as it is to have the right caliber and type of guns for each specific military operation.

Only Ingersoll-Rand Jackbits cover the complete size-range from 1⅜ to 4½ inches. In addition, there are many different designs from which you can select a bit that will give you the best drilling efficiency in any particular kind of rock. There are bits developed especially for the hardest rock . . . for abrasive or sticky ground . . . for ground that tends to rifle or that binds the bit . . . for ground that requires maximum bit clearance.

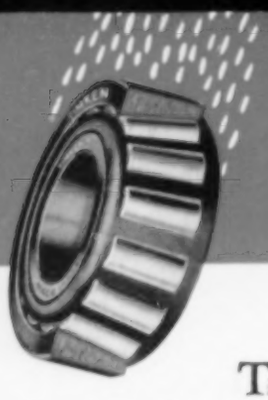
Because of these advantages, the use of Jackbits among mining men, quarry operators, and contractors is increasing daily. The Army and Navy like Jackbits too, because there is a proper type available for any job—no matter what the location. Moreover, Jackbits are backed by the only complete line of reconditioning equipment; hence there is no divided responsibility to annoy the user or waste his time.

Ingersoll-Rand

11 BROADWAY, NEW YORK 4, N. Y.

15-336

COMPRESSORS • TURBO BLOWERS • ROCK DRILLS • AIR TOOLS • OIL AND GAS ENGINES • CONDENSERS • CENTRIFUGAL PUMPS



TIMKEN BEARINGS *on the Alcan Highway*

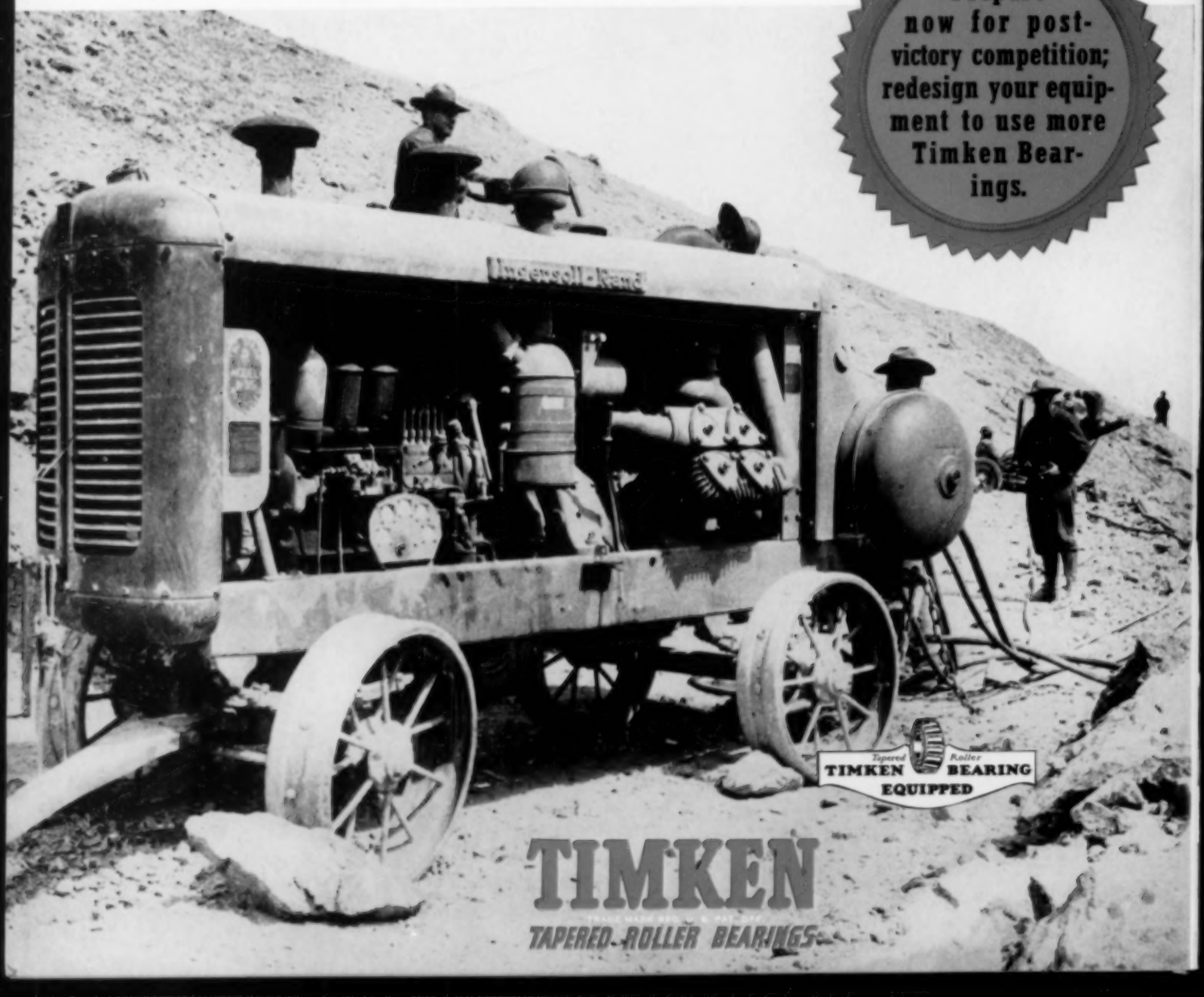
Timken Tapered Roller Bearings are used in a great majority of the machines employed in the construction of the Alaska-Canada military road. A typical example is this Ingersoll-Rand Model IK-315 Mobil-Air Compressor which is equipped with Timken Bearings in the wheels and on the compressor crank shaft.

Ingersoll-Rand Model FM-2 Wagon Drills were used in conjunction with the compressors. These also are equipped with Timken Bearings — 8 per machine, 4 in the worm gear drive and 2 in each wheel.

Wherever Timken Bearings are used — in construction equipment of all kinds — superior performance, greater endurance and lower operating and maintenance costs are the rule; the more Timken Bearings there are in any machine the better the results. Make sure they are used at every suitable position in your equipment. The Timken Roller Bearing Company, Canton, Ohio.

Ingersoll-Rand IK-315 Mobil-Air Compressor equipped with Timken Bearings working on the northern section of the Alcan Highway, supplying air to I-R Timken Bearing Equipped Wagon Drills.

Prepare now for post-victory competition; redesign your equipment to use more Timken Bearings.



TIMKEN

TAPERED-ROLLER BEARINGS